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# The Southern Surgeon

**University of Oklahoma School of Medicine Number**

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# The Southern Surgeon

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## A SUCCESSFUL EMBOLECTOMY AT THE BIFURCATION OF THE AORTA

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ADVANCES in vascular surgery permit early diagnosis and successful removal of an embolus lodged at the bifurcation of the aorta. According to a recent review, 23 such operations have been successfully performed and recorded. An additional case of particular interest, because of the patient's age and time of survival, is presented.

### CASE REPORT

C. F., a 74 year old white female, was admitted to St. Anthony Hospital at 7:00 a.m., Sept. 6, 1946. On that morning, at 5:30, she had awakened with pain in both legs. At first the left, and then the right leg became numb. Subsequently, she had several involuntary bowel movements. For the preceding 3 years she had been under treatment for arteriosclerotic heart disease with decompensation and auricular fibrillation.

On admission, the patient displayed evidence of peripheral vascular collapse and was acutely ill. There was almost complete loss of muscle power in both lower extremities. The skin of both legs was cold, and the legs and feet were pale and white. No edema was present. There were no femoral, popliteal or dorsalis pedis pulsations in either leg. Cutaneous sensation was absent in the left leg although present in the right. Her blood pressure was 220/110. The heart rate was irregular. The hemoglobin was 8.5 Gm., red blood cell count 3,110,000. The white blood cell count was 18,200 with 82 per cent neutrophils and 18 per cent small lymphocytes. The urine was straw-colored, slightly cloudy, acid reaction, specific gravity 1.017, albumin 2 plus, slight trace of glucose, and the spun sediment showed numerous red blood cells.

Surgery was performed 4½ hours after the onset of symptoms. The approach was retroperitoneal, through a muscle splitting incision to the left of the rectus muscle. The transversalis fascia, the ureter, and other retroperitoneal structures were reflected medially. The common iliac artery, the bifur-

From the Department of Surgery, the University of Oklahoma School of Medicine and the University Hospitals.

cation of the aorta, and the distal portion of the abdominal aorta were exposed without difficulty. Both common iliac arteries were pulseless and a pulseless mass filled the bifurcation of the aorta. The first portion of the left iliac artery was opened between encircling pieces of tape, after tightening the distal tape. A glass tube was passed and a portion of the embolus removed by suction. The vessel was still occluded and the remaining material was gently milked down through the incision and lifted out with forceps (fig. 1A). It

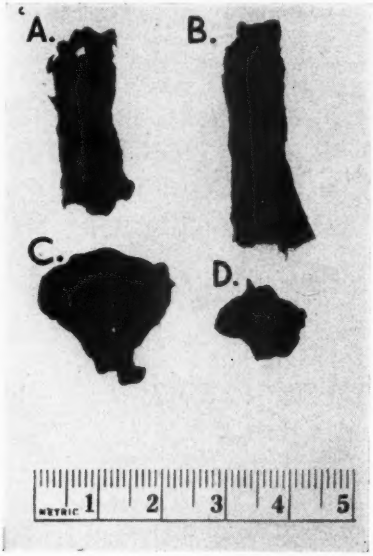


Fig. 1. A—Cast removed from left common iliac artery. B, C, D—Thrombi removed from aorta.

appeared to be an atheromatous cast that had either been dissected or manipulated free from the common iliac artery at the junction of the aorta. There was still no free flow of blood. A glass suction tip was inserted into the bifurcation and a large thrombus followed by broken pieces of thrombi (fig. 1 B, C, D) was obtained. A brisk flow of blood indicated free flow from the aorta. The tape was tightened proximal to the opening in the iliac artery. Pulsation was then present in the right common iliac artery and the incision in the wall of the left common iliac artery was closed with a continuous over and over suture of 000000 silk everting the intima in the process. In a short time both feet began to show improvement in color. She was given 50 mg. of heparin intravenously on the operating table. The wound was closed in layers and a light dressing applied. The operation lasted one hour and thirty-five minutes and, at the conclusion of surgery, her condition was much improved.

Intravenous glucose 5 per cent 1,000 c.c., containing 100 mg. of heparin was given at the rate of 25 drops per minute. At 1:00 p.m. her pulse was 88, respiration 19, and the clotting time 10 minutes and 40 seconds. Heparin was continued for the next 48 hours in an attempt to stabilize the clotting time at

15 minutes. Demerol was used for sedation. Oral dicumarol was started as soon as she could retain fluids. At 2:00 o'clock, the nurse noted that she was moving her legs.

At 8:00 p.m. on the second postoperative day, a tumefaction appeared over the incision. Immediate probing yielded approximately 500 c.c. of serosanguineous fluid containing some fresh blood. Heparin was discontinued and a transfusion with 500 c.c. of fresh whole blood and 60 mg. of hykinone was given. The hykinone was repeated in 30 mg. doses every 4 hours. The following morning a transfusion of 500 c.c. was given and repeated 4 hours later.

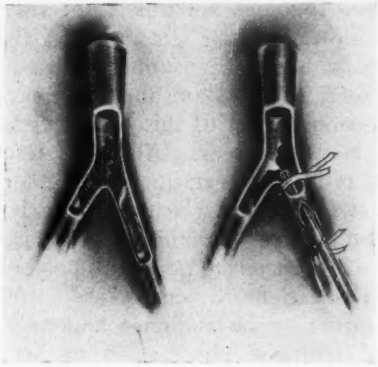

Fig. 2. Dissecting thrombus and method of aspiration.

She was slightly irrational and her pulse was 100. After hemorrhage was controlled, hykinone was discontinued and dicumarol was resumed. The prothrombin time gradually rose from 25 per cent on the 3rd postoperative day to 58 per cent on the 7th postoperative day. On the 10th postoperative day the prothrombin time was 24 per cent of normal. She was up in a chair on the 5th postoperative day and went home on the 10th postoperative day. During the following year a prothrombin level of 50 per cent was fairly successfully maintained. She has received dicumarol regularly until the present time, the dosage being governed by prothrombin determinations. Although, after the first year, the prothrombin level was not maintained as carefully as desired, subsequent embolism has not occurred.

## Discussion

Embolus at the bifurcation of the aorta is not as rare as is commonly supposed. Most of the cases have resulted in fatalities because of late diagnosis and treatment. Advances in surgery and therapy during the past few years have rendered embolectomy a successful procedure, if performed within the first few hours.[1] The anticoagulant drugs have contributed immeasurably. Theoretically, anticoagulant therapy should prevent recurrence of emboli.[2] Without embolectomy, the mortality in acute complete obstruction at the bifurcation of the aorta is nearly 100 per cent.[3-5] Occasionally, the accompanying thrombus or embolus may slide into one common iliac

artery with the resultant loss of only one leg. An occasional patient is reported to be alive and well following bilateral amputation.[6]

## Diagnosis

Slowly progressive obstruction must be ruled out by the history. Such a condition can occur in arteriosclerosis obliterans or in the syndrome of chronic progressive non-sclerosing thrombosis at the bifurcation of the aorta. Usually, in acute obstruction, there will be pain in the lower abdomen but this is not always true.[7-10] This symptom will be followed by pale feet and legs, with mottling of the thighs and absence of femoral pulsations bilaterally. Usually, loss of power, paresthesia of the skin, and evidence of shock will be present. Five additional cases of this character have been seen by the author in the last three years. All were seen too late for embolectomy and all resulted in fatalities after one or both legs had been amputated. A few points which aid in early diagnosis should be emphasized. First, every complete physical examination should include palpation of the femoral, popliteal, posterior tibial and dorsalis pedis arterial pulsations. Second, every acutely ill patient complaining of discomfort in the abdomen and/or in the legs should have a carefully continued observation of his femoral arterial pulsations.

## Summary

A successful embolectomy at the bifurcation of the aorta in an individual 74 years of age is reported. The patient is still living 34 months postoperatively and has had no additional emboli up to this time.

Routine examinations of the femoral arterial pulsations in a physical examination is important.

As a preventive measure, anticoagulant therapy over a prolonged period merits consideration.

Embolectomy at the bifurcation of the aorta is feasible by a direct approach to the left common iliac artery through a muscle-splitting incision.

Only 23 successful embolectomies at the bifurcation of the aorta are reported in the literature.

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# CARCINOMA OF THE BREAST OCCURRING DURING PREGNANCY OR LACTATION

## Report of 12 Cases

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CONFLICTING evidence has recently been presented as to the advisability of radical mastectomy for carcinoma of the mammary gland appearing during pregnancy or lactation. Physiologic stimulation of the mammary glands occurring during pregnancy and lactation renders a co-existing carcinoma particularly malignant. It has been stated that radical mastectomy offers no prospect of cure for carcinoma developing in the breast during these periods. Furthermore, it may actually shorten the life expectancy. Other reports have not been so pessimistic about the results of radical mastectomy in such instances.

A survey of patients with carcinoma of the mammary gland treated at the University of Oklahoma Hospitals since 1930 revealed 12 patients in whom the carcinoma was detected during pregnancy or lactation and who were subjected to mastectomy.

### ANALYSIS OF CLINICAL DATA

The principal clinical data are summarized in Table I.

The ages of the patients varied from 22 to 47 years, with an average of 36 years.

In two of the patients (Cases 1 and 8) the neoplasm was discovered during pregnancy. In 7 patients, the growth became apparent in the postpartum period. Those patients who did not lactate noticed the lump earlier as the breasts lost their engorgement. One patient (Case 6) had some bleeding from the nipple 4 months before the growth was detected.

The average delay between the discovery of the "lump" and operation was 24.3 months. A mass was present in 5 patients for over 2 years, 3 patients believed that the lump had been present for about 5 years before operation.

The individual records contained incomplete information about involvement of the axillary contents. In 5 instances enlargement of lymph nodes was observed clinically while the nodes were not mentioned in the operative record nor in the pathologic report. In some

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TABLE I—SUMMARY OF CLINICAL DATA

| Case Number | Age | Lump Noticed | Months Elapsed Before Operation | Post-operative Survival, Months | Survival from Appearance of Growth | Remarks |
|---|---|---|---|---|---|---|
| 1 | 22 | 3rd month of pregnancy | 3 | 1 | 4 | Widespread pleural, pulmonary and liver metastases—necropsy |
| 2 | 30 | 1st month of lactation | 5 mo.-Simple Mastectomy<br>8 mo.-Radical Mastectomy | 9 | 17 | Local recurrence; metastases to liver |
| 3 | 35 | 10th day post-partum | 12 | 9 | 21 | Bilateral pulmonary metastases |
| 4 | 35 | 3rd month of pregnancy | 8 | 17 | 25 | No information |
| 5 | 37 | 10th month of lactation | 5 | 11 | 16 | Pleural effusion; metastases to vertebrae, pelvic bones and to opposite breast |
| 6 | 38 | 1 month after miscarriage | 11 | 28 | 39 | Local recurrence; pathologic fracture of hip; metastases to opposite breast |
| 7 | 38 | 19th month of lactation; weaned 4 months later | 6 | 7 | 13 | Local recurrence; pleural effusion and multiple pulmonary metastases |
| 8 | 39 | 24th month of lactation | 36 | 8 | 44 | Metastases to bony pelvis and femur |
| 9 | 40 | 1st month post-partum; did not nurse infant | 55 | 3 | 58 | Widespread metastases to liver and lungs—necropsy |
| 10 | 47 | 5th month of lactation; bleeding 1st month | 28 | 31 | 59 | No information |
| 11 | 40 | 2nd month of lactation | 60 | Living 20 months postmastectomy | | Simple mastectomy, 8-8-47; biopsy local recurrence, 12-11-48 |
| 12 | 32 | Ulcerated area throughout 2 pregnancies | 60 | Living 1 month postmastectomy | | Paget's disease of nipple with intraductal carcinoma; radical mastectomy, 3-3-49 |

Parker and Aldredge.

patients, the lymph nodes were apparently not removed; in some the pectoral muscles were not excised. The radical block type procedure described by Halsted[1] was performed in only one patient (Case 12). Thus it is apparent that most of these patients had palliative rather than radical operations. Though the operations performed were conservative, only 3 of the patients lived long enough to develop local recurrence.

Of the 10 patients who died, 5 had pulmonary metastases; 3 had metastases to the liver and 3, metastases to the skeleton. The longest postoperative survival in the 10 patients who died was 31 months. The average postoperative survival time was 12.4 months. The youngest patient (Case 1) died one month after mastectomy with widespread metastases that must have been present at the time of operation. The 2 living patients are now 20 months and 8 weeks respectively postmastectomy.

The average survival time from appearance of the tumor until death was 29.6 months. None of the fatalities survived 5 years. The 2 living patients are exceeding this limit. One patient (Case 11), living for almost 7 years since the tumor was first noticed, is now 20 months postmastectomy, and has local recurrence.

Patient 12 deserves special mention. She had Paget's disease of the left nipple with intraductal carcinoma. It was present throughout two pregnancies, and her children are 3 and one years old. She did not nurse either child. She recently was treated by radical mastectomy. The lesion appeared to be localized to the nipple and areola; no axillary involvement was found.

## Discussion

The results of surgical treatment of these patients have been disappointing. It is obvious, however, that almost all were seen too late for effective treatment, and that only one of the patients had a real radical mastectomy. From this series, therefore, no conclusions can be drawn as to the value of surgical treatment for breast carcinoma developing during pregnancy or lactation.

Reviews of the problem of cancer of the breast in association with gestation or lactation have emphasized the highly malignant type of these neoplasms, as reflected by the histologic grading. None of the 92 cases reported by Harrington[2] was Grade I carcinoma, and nearly 60 per cent were Grade IV. In this series, the largest reported to date, the 5 year survival rate was 14.5 per cent. On the basis of comparative survival figures, Harrington concluded that carcinoma of the mammary gland developing during pregnancy was of more serious consequence than that appearing during lactation.

On the other hand, Haagensen and Stout[3] have concluded that operative intervention in such cases offered little hope of 5 year cure, and radical operative procedures actually shortened the average life expectancy. They based their conclusions on 29 patients with carcinoma of the mammary gland developing during pregnancy or lactation, 20 of whom had radical mastectomy. More recently Haagensen[4] "is inclined to modify" his first provision so that associated pregnancy or lactation no longer commits the patient with carcinoma of the breast to the "categorically inoperable."

The results of radical mastectomy in 6 patients were recently published by Brooks and Proffit.[5] Three of their patients developed the carcinoma while pregnant and 3 while lactating. One patient had survived for 15½ years at the time their article was submitted; 5 had succumbed to recurrent disease.

The physiologic adjustment to pregnancy or lactation exerts a profound influence on the mammary glands. The intense stimulation accelerates the rate of growth in a co-existing carcinoma and the increased blood flow favors its rapid dissemination. If these patients are to be treated effectively, early detection must be the keynote. Haagensen[4] and others have emphasized that systemic spread and distant metastases are the *bête noire* in carcinoma of the breast, particularly when associated with pregnancy or lactation. The obstetrician can make one of his greatest contributions by complete neonatal and postnatal examinations, including particular attention to the breasts.

There is fairly general agreement as to the desirability of operative treatment. Rules have been evolved to meet the various situations. According to Geschickter[6] "therapeutic abortion is indicated in the first two-thirds of pregnancy if the disease is not hopelessly extensive at the time." The pregnancy is terminated preliminary to treatment of the breast itself. If the pregnancy is of less than 5 months' duration, and the breast lesion is operable, Chase[7] advises that, "the pregnancy should be interrupted at once, testosterone given daily in large doses, and the radical operation with adequate transfusions should be done as soon as the patient's condition permits." After 5 months' gestation, "hysterotomy, tubal ligation, transfusions, and radical operation should be the plan."

It seems, however, desirable to attack the lesion directly as soon as suspicion has been cast. Women suspected of having carcinoma of the breast during pregnancy or lactation should, in the absence of demonstrable distant metastases, have biopsy and radical operation at the earliest moment. Delay for interruption of pregnancy or waiting for a term delivery is ill-advised. Complete radical removal

of the neoplasm need not interfere with the subsequent course of pregnancy. Naturally, if the neoplasm is completely removed, the stimulating effect of pregnancy or lactation is eliminated.

The various criteria of Haagensen and Stout[3] are excellent guides to determine whether or not the local lesion is operable. Every effort must be exhausted to discover bony, pleural, mediastinal or other metastases before subjecting the patient to radical mastectomy. Most of these patients will be considered inoperable when first examined.

It is a grave decision to withhold radical mastectomy in any patient with carcinoma of the breast. Radical surgery offers the only hope of lasting cure for cancer of this particular organ. However, when the entire disease cannot be eliminated, the operation serves no real purpose. It might be deemed wise, therefore, not to jeopardize needlessly the place of radical cancer surgery by operating on patients known to have irremovable carcinoma. If the patient with incurable cancer is to be denied surgery, then some attempt at palliation must be made. Irradiation probably offers the most effective palliation in such a case.

## Conclusions

An analysis is presented of the clinical course, operative treatment, and the end results in 12 patients who developed carcinoma of the mammary gland during pregnancy or lactation. Most of the patients when they came under observation were already in an incurable state and thus the operation was palliative. It is concluded that if the diagnosis can be made early, before distant metastases are apparent, radical mastectomy should be performed.

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# CLINICAL PATHOLOGIC CONFERENCE

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DOCTOR HALPERT: Occasionally a patient comes under observation too late in the course of the disease to permit diagnosis and effective treatment. The patient whose story we are presenting today is an example of such a situation.

## CLINICAL DATA

*Patient:* R. G., a 29 year old white woman, was admitted February 23, and died Feb. 25, 1948.

*Chief Complaint:* Pain and swelling of abdomen; vomiting.

*Present Illness:* On February 2, the patient suddenly experienced a cramp-like pain in the left upper quadrant of the abdomen, radiating into the left chest. The next day she began to vomit a green or yellow, bitter-tasting material. On the second day of illness she was admitted to the Polyclinic Hospital. Gastric suction and intramuscular penicillin therapy were instituted. The vomiting subsided; the abdominal pain and soreness persisted. The patient left the hospital against advice after 2 days. After discharge the pain became more severe and vomiting recurred. On occasions near the end of a vomiting seizure, streaks of blood were noted. Vomiting became more severe on February 10. The pain seemed to subside following vomiting. The patient had colonic irrigations on several occasions; there was no bowel movement for a period of about 10 days.

On February 22 the abdomen began to swell, and vomiting persisted until the patient was admitted to the University of Oklahoma Hospitals on February 23.

*Past History:* Two years previously she had had a bilateral salpingectomy and appendectomy and since then had been in poor health. She was para 3, gravida 3. Her youngest child was 6 years old.

*Family History* was non- contributory.

*Physical Examination:* At the time of admission she was well developed, well nourished, acutely ill. The temperature was 98.6 F., pulse rate 96, and respiratory rate 24. The blood pressure was 94/60. The lungs were clear to auscultation and percussion. The heart rate was regular, no murmurs were heard. There was marked distention of the abdomen, and generalized tenderness. No masses or herniae were palpable. Fluid wave was not present. Tinkling bowel sounds were heard. On rectal examination, no masses were felt. The cervix was immovable. Fecal material on the examining finger was not bloody.

*Laboratory Data:* On February 24 the urine was straw-colored, cloudy, with a pH of 8, and specific gravity 1.010. Traces of albumin and glucose were present. There were 2 to 3 white blood cells per high power field and

From the Department of Pathology and the Department of Surgery, the University of Oklahoma School of Medicine and the University of Oklahoma Hospitals.

scattered phosphate crystals. The red blood cell count was 4,300,000 with hemoglobin 14 Gm.; the white blood cell count was 17,200 with neutrophiles 90 (stabs 2), lymphocytes 5, and monocytes 5 per cent. On February 25 the urine was straw-colored, cloudy, with a pH of 4.5, and specific gravity 1.010. Albumin reaction was 1 plus, and glucose, 2 plus. A few bacteria were present. There were 15 to 20 red blood cells and 50 to 75 white blood cells per high power field. The N.P.N. was 120 mg. per cent. The blood sugar was 206 mg. per cent.

*Clinical Course:* The patient's condition remained critical. She was treated with glucose, amigen, and transfusions of whole blood. Sedatives were given as needed. Continuous suction with a Miller-Abbott tube was carried out in an effort to collapse the distended bowel. The tube, however, did not pass the pylorus. On February 25 at 2:00 a.m. the patient became comatose; temperature rose to 103.4 F.; the pulse was not palpable, and blood pressure was unobtainable. The cardiac rate became rapid, and the sounds distant. Plasma, whole blood, and intranasal oxygen were administered. Her condition became worse, and she died at 7:30 a.m. Feb. 25, 1948, 36 hours following admission to the hospital.

## Clinical Discussion

Doctor Parker: My information on this patient is limited to that provided in the Clinical Data. The patient was a 29 year old white woman who died 2 days after admission to the University Hospitals. Her chief complaints were pain and swelling of the abdomen and vomiting. The onset of illness, almost 3 weeks previously, was sudden, with cramplike pains in the left upper quadrant radiating into the left chest. One day after the onset of colicky pain there was vomiting of green or yellow, bitter-tasting material. The bile in the vomitus indicated an obstruction below the site of entrance of the common bile duct. Occasionally, near the end of a vomiting seizure, streaks of blood were noted in the vomitus. Blood in the vomitus would not necessarily indicate a lesion of the stomach or duodenum since persistent vomiting is frequently accompanied by the appearance of flecks of blood in the vomitus. On the second day of illness the patient was treated in a hospital, with gastric suction and penicillin. The vomiting subsided—indicating that the stomach and duodenum had been relieved of their contents. After 2 days the patient left the hospital. Vomiting became more severe on February 10; pain seemed to subside following vomiting. If the intestine were distended by gas and liquid content, vomiting would naturally relieve the pain. An important part of the history is the fact that the patient did not have a bowel movement for a period of 10 days. The colonic irrigations are merely mentioned. On February 22 the abdomen began to swell.

The sequence of events, the onset of colicky pain in the upper abdomen, the vomiting which followed the onset of pain, and finally,

distention of the abdomen, is particularly important. The past history discloses a bilateral salpingectomy and appendectomy 2 years previously. At the time of admission the patient was acutely ill. Her temperature, however, was essentially normal, while her pulse and respiratory rates were increased. The blood pressure was relatively low, 94/60. The lungs were clear and the heart rate was regular. There was marked distention of the abdomen and generalized tenderness, the first mention of the latter finding. No masses or herniae were palpable. This is a significant observation in a case of suspected intestinal obstruction. There was no fluid wave present, and tinkling bowel sounds were heard, indicating dilatation of loops of intestine and persistent peristaltic rushes. On rectal examination no mass was felt and the cervix was immobile. It might be presumed that an inflammatory mass had fixed the cervix. On the day of death there were 15 to 20 red blood cells and 50 to 75 white blood cells per high power field, with an N.P.N. of 120 mg. per cent. This is almost four times normal, indicating some degree of renal failure. The N.P.N. appears unusually high for azotemia of this type although some elevation is expected in case of intestinal obstruction with persistent vomiting and depression of blood chlorides. The blood sugar was 206 mg. per cent. That may not be significant since the patient received glucose throughout hospitalization. An apparently unsuccessful attempt was made to decompress the intestine with a Miller-Abbott tube. The patient became comatose, her temperature rose to 103°, the pulse became extremely rapid, the heart sounds became distant, and the patient died.

So, in summary, we have a young woman who was ill approximately 3 weeks, starting with colicky pain followed by vomiting and absence of bowel movements. Since there was generalized tenderness throughout the markedly distended abdomen, peritonitis is immediately suspected. This is supported by the accelerated pulse rate and the elevated white blood cell count.

May we see the x-ray, Doctor Bender?

DOCTOR BENDER: The roentgenogram of the abdomen discloses markedly dilated loops of small bowel arranged in stepladder fashion (fig. 1). The visible valvulae conniventes indicate that the distended bowel is small intestine. Little or no gas is evident in the colon. A shadow low in the pelvis might be interpreted as a distended urinary bladder or an inflammatory mass. The x-ray evidence suggests there is a small bowel obstruction.

DOCTOR PARKER: Clinical findings in this case point to a mechanical obstruction of the small bowel. There are very few conditions that can be confused with a simple mechanical intestinal obstruction.

The onset of cramping pain and vomiting without local tenderness or other findings in the abdomen usually indicates an acute colic that might be due to mechanical obstruction, to allergic enteritis, or to acute infectious gastroenteritis. However, the diarrhea that follows shortly after both the allergic enteritis and the infectious gastroenteritis serves to differentiate these conditions from true intestinal obstruction. The absence of diarrhea is fairly good evidence that

Fig. 1. Flat plate of the abdomen, showing marked distention of loops of small intestine in a stepladder pattern with the valvulae conniventes clearly discernible. No gas is evident in the colon.

the obstruction of the bowel was mechanical. The history of a previous laparotomy would lead one to suspect the presence of adhesions. Adhesions will usually cause complete or incomplete obstruction of the small bowel, rather than the large bowel. Intestinal obstruction may be simple and mechanical or it may be strangulating. The difference lies principally in the integrity of the blood supply. In simple obstruction the lumen alone becomes occluded, whereas, in strangulating obstruction, the blood supply as well becomes compromised. Even in simple, mechanical, obstructions that are prolonged and unrelieved, there is distention of the bowel from peristaltic rushes, swallowed air, and increased secretions. This may increase intraluminal pressure to such a degree that the blood supply is not adequate to maintain the viability of the wall and gan-

grene will supervene, resulting eventually in perforation of the gut with free communication between the lumen of the intestine and the peritoneal cavity. This may result in widespread contamination, or it may become a localized abscess. In this instance I believe that the patient had initially a simple mechanical obstruction due to postoperative adhesive bands and that, since the obstruction was not relieved, the distention impaired the viability of the gut wall. Due to the increased intraluminal pressure the mechanical obstruction was converted into a strangulating obstruction. The obstruction was probably in the lower jejunum or upper ileum since the distention became a prominent sign so late in the disease. The obstruction was probably incomplete at first, but the continued pounding against the site of obstruction produced edema of the wall and complete obstruction resulted. In my opinion, the bowel probably perforated due to the increased pressure and gangrene of the gut wall, and peritonitis was the actual cause of death.

## Necropsy Findings and Comment

Doctor Halpert: At necropsy the skin was pale, not icteric. There was no generalized edema. The abdomen was prominent and tense. There was a midline scar 11 cm. long below the umbilicus and there were some striae in the lower abdomen. The peritoneal cavity contained about 600 c.c. of foul smelling thick brown liquid, apparently tinged with some intestinal content, indicating the presence of terminal perforation. All the peritoneal surfaces were covered with a thick fibrinopurulent exudate and discolored brown and red. The great omentum covered some of the distended loops and was discolored angry red. Adjacent loops of the small intestine were lightly bound together by easily torn fibrinous adhesions. There was pus in the pelvis so that the pelvic organs were swimming in this liquid. The small intestine was most markedly distended at a point 120 cm. distal to the duodenojejunal junction. Here a band of connective tissue appeared to tie the intestine with another loop about 60 cm. proximal to the ileocecal region. Where this band of adhesions, hardly 2 cm. long and 0.3 cm. thick, created a space between the mesentery and the intestines, the intervening segment of small intestine 150 cm. long came through, became distended and twisted, then partly devitalized and finally involved in an inflammatory process (fig. 2). At one end of the segment of intestine there was a small hole through which fecal content could be seen to ooze when the intestine was moved. There was, however, no real fecal content mixed with the exudate covering all the surfaces. This suggests that peritonitis was present first, followed by perforation.

There were no pertinent changes in the other organs. The liver

was pressed upward about 2 cm. above the costal margin, and the diaphragm was at the level of the 4th interspace on both sides. The lungs were each increased in weight about 100 Gm. and the lower lobes were slightly atelectatic suggesting a beginning inflammatory

Fig. 2. Band of adhesions between loops of small intestine forming an opening through which loops of small intestine passed and became distended, twisted and partly devitalized.

process. The heart was of usual size and there were no changes in the orifices and valves. There was some protein coagulum or precipitate in some of the convoluted and collecting tubules of the kidneys. This would be in line with the slight increase in protein content of the urine and also with the terminal increase in the N.P.N.

Had there been no history of a previous operation, possible causes other than adhesions might have been considered. The remains of a Meckel's diverticulum still connected with the umbilicus may form a cord around which intestinal loops might twist and become obstructed.

Occasionally a hole may spontaneously occur in the mesentery and through it portions of the small intestine may be forced by peristalsis with similar results. There may be other kinds of peritoneal pockets into which the gut may herniate, such as in retromesocolic hernias. A segment of gut may have a free or long mesentery around which it may become twisted, causing obstruction. Another

type of mechanical obstruction is caused by a small pedunculated neoplasm that grows to a size sufficient to obstruct the lumen. The gut wall may press such a neoplasm down into the lumen, telescoping the adjacent portion into a distal part of the intestine. In such an instance, blood would probably have appeared in the stool and intussusception would have been diagnosed.

The history of a laparotomy in this case made it safe for Doctor Parker to assume that bands of adhesions caused the obstruction. When the patient was admitted to the hospital there was too much distention to permit surgical intervention, and the patient died before effective decompression could be achieved.

The final anatomic diagnosis was:

Scar of operation: appendectomy and bilateral salpingectomy.

Fibrous adhesions between loops of small intestine with torsion and strangulation of loops; gangrene, early, with peritonitis, acute, diffuse, and terminal perforation(?).

# PARALYTIC ILEUS

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PARALYTIC ileus, a dreaded surgical complication, has been variously called reflex inhibition, adynamic, or functional. It is made up of those cases of intestinal obstruction in which there is a *complete absence* of motility or propulsive power in the intestinal tract but without any demonstrable lesion. Even though there is no mechanical obstruction the intestine becomes progressively distended with gas and fluid and loses its power of contraction. This paralysis may involve the whole intestine or, again, only limited segments of the gut. In paralytic ileus there are likewise varying degrees of intensity or severity as different parts or lengths of the intestine may become paralytic. Ochsner has stated that "A transient physiological ileus is invariably present after laparotomy which is just as true as the ileus that produces an adynamic or paralytic variety." Many series investigated show that 50 to 75 per cent of celiotomy cases are followed by gas pains or signs of intestinal atony. On occasion, death has resulted even though only a segment of the bowel was implicated.

An analysis of many reported series of cases strikingly reveals how much more serious a condition is paralytic ileus than mechanical ileus. Mortality tables show the reduction in mortality in intestinal obstruction as a whole has been brought about by the alert, prompt recognition and treatment of acute complete mechanical obstruction, and not by any improvement in the mortality in paralytic ileus. Complete mechanical intestinal obstruction is suspected and treated promptly and specifically. Incomplete mechanical obstruction may be suspected but all too often is treated conservatively too long and the mortality therefore remains definitely higher for incomplete than for complete obstruction. The mortality in paralytic ileus is still more than double the mortality in mechanical ileus. "Procrastination is the thief of time." Why the high mortality or lack of improvement in the management of paralytic ileus? Is it suspected with sufficient apprehension, or is there an attitude of "laissez faire" in its early development during the so called "gas pain" period? Too late, a paralytic ileus presents, in reality, a terminal ileus, now made obvious by its resultant and accompanying peritonitis. Or again, is it inability, lack of understanding or improper management which maintains this too high mortality?

Paralytic or functional ileus occurs to a mild degree following any abdominal operation. Intraperitoneal hemorrhage, peritonitis, ruptured viscus, torsion of the omentum, torsion of any ovarian

cyst have as part of their clinical picture some grade of ileus. Paresis to some extent accompanies fractured ribs and pneumonia, any blunt trauma to the abdomen, injury to the spine, fractured pelvis, or even fractured femur. Renal trauma, renal colic, retroperitoneal hemorrhage or a full bladder all have an associated ileus. Intestinal activity is unaffected by a distended gallbladder but distention of the urinary bladder caused inhibition in all the loops of the ileum and one half of the loops of the jejunum. Over-hydration or too great enthusiasm in giving salt solution produces functional ileus. It may be one of the complicating problems in circulatory embarrassment, coronary occlusion, or dissecting aneurysm. As recently as May of this year 5 proved cases of paralytic ileus were reported in Surgery, Gynecology & Obstetrics due to low Vitamin B or nutritional deficiency.

The majority of cases of true paralytic ileus terminate in peritonitis and are usually classified and recorded as peritonitis. It is consequently impossible to obtain correct and complete case histories of true paralytic ileus. The predisposing factors brought out in the preceding paragraph are evidence that the real cause of ileus is not a local one. The mechanism is not clear. Extrinsic nerves play an important role in the motor inhibition. The vagus is the motor nerve to the greater part of the intestine and the influences of the sympathetic are inhibitory to the bowel and motor sphincter. By shunting out the sympathetics, one can relieve paralytic ileus, and the intestine again contracts. The gut had not been paralyzed, literally speaking, but its activity was inhibited by the overactive sympathetic influence.

In good health, intestinal sounds are always audible. These are most pronounced after eating and have a certain regularity. Activity of the intestine is constant even though one meal a day is eaten and the rate and amplitude of the peristalsis decreases from above downward. When food is given an almost quiescent intestine, marked activity bursts forth. Active peristalsis takes place whether liquid or solid food is ingested, but the movements following liquids are less pronounced and shorter in duration.[38] Ether and abdominal exploration cause cessation of peristalsis for 4 hours and so-called physiologic ileus becomes apparent. Following resection and intestinal anastomosis there is cessation of peristalsis for at least 24 hours. Early in the developmental stage of inhibition ileus, distention occurs. Four to 8 hours following laparotomy the first sounds of peristalsis are heard; irregular, turbulent, and often accompanied by pain. Infrequent in the beginning, later almost continuous and lacking coordination, peristalsis finally becomes regular, propulsive

and painless. Flatus is expelled and the stage of coordination is reached, elimination ensues and recovery follows.

As previously stated, the mortality in acute paralytic ileus is double the mortality in incomplete mechanical obstruction and more than 5 times the mortality in complete mechanical obstruction. Why? Distention of the intestine early impairs absorption. The gas in the intestine which is normally carried away as fast as it is formed continues to accumulate. Progress of the developing post-operative ileus may not be observed closely or taken seriously. A single segment or the entire small bowel may be dilated and paralytic ileus in reality soon presents itself. The degree of dilatation may vary considerably and usually large collections of fluid and gas accumulate. The bowel wall thins out, and its surface becomes dull and dusky. Edema of the intestine is progressive, suggesting obstruction. A pressure of 55 or 65 millimeters of mercury within the gut causes pressure on the veins which encircle the ileus, and interferes with absorption, again increasing the distention. Progressive distention can cause arterial compression.

The fluid in the bowel of paralytic ileus is thin, brownish, and flaky. The greater part is comprised of saliva, gastric juice, bile and pancreatic and intestinal secretions, normally amounting to ½ to 10 liters per day. It is toxic and with distention the capillaries of the mucosa become more and more permeable. The contents transude into the peritoneal cavity. Water is now absorbed by the peritoneum and fluid more and more like plasma is the result. Loss of plasma from the circulation becomes considerable and loss of plasma means decrease in bowel motility, probably now due to edema. A vicious circle is thus created.

The intestinal distention has now impaired the tone, motility, local circulation of the bowel and its secreting and absorptive functions. Circulatory failure as it is applied to the gastro-intestinal tract, may be abrupt and fulminant; as the bowel can survive no more than 6 hours of complete anemia. Anti-mesenteric distention necrosis may follow. Blood plasma loss precipitates the shock syndrome. Unrelieved excessive intestinal distention favors the development of phlebothrombosis, pulmonary embolism, thrombophlebitis and atalectasis.

Small bowel distention threatens to become paralytic ileus and should be suspected always, for ileus is a clinical entity which exists when mild degrees of gastro-intestinal dysfunction persist, progress and resist the usual decompressive methods. Painless mild distention of the abdomen 36 to 72 hours following trauma or surgery characterizes the onset. The abdomen is silent and progressively and usually rapidly distends. Tenderness is not a factor until the

distended gut begins to seep and peritoneal irritation results. The respirations are thoracic in type, the pulse more rapid, and the temperature not elevated. Very little, if any, pain is present. Severe thirst may exist with the patient regurgitating large amounts of fluid ingested. Absolute constipation is not essential to the diagnosis but is usual and inability to express flatus has been puzzling. Enemeta give poor results or none.

There is an absence of localizing physical signs. There are no cramps, colic or pain except the distensile general pain referred to the back from stretching of the mesentery. The percussion note is tympanitic over the entire abdomen. The ileus may be overlooked because it cannot be seen, felt, or heard. Most impressive is the complete absence of peristaltic sounds. Strictly speaking, the abdomen is not always silent, for a few tinkles due to movement of fluid and gas may be heard. The breath and heart sounds may often be heard over the distended, quiet abdomen. An early tachycardia is evidence of peritoneal irritation. The blood pressure is low, the pulse rapid. The temperature is rarely elevated except late in the disease. The urinary secretion is diminished. The leukocyte count is normal or subnormal unless elevated by dehydration as will be the red cell count. Rectal examination may reveal anorectal spasm, distended loops of bowel, and gas in the rectum. Decompressive measures failing, persistent vomiting will develop and tenderness and rigidity become apparent as peritoneal involvement becomes obvious.

Taken advantage of early, the x-ray survey or scout film will diagnose ileus before there is any clinical evidence of intestinal distention and subjective symptoms are appreciable. The patient should be preferably in the erect posture several minutes before the roentgenogram is made. Fluid levels may be discernible and the presence of gas in the small bowel gives diagnostic working evidence. In spite of characteristic signs and symptoms the differentiation between mechanical and paralytic ileus may be difficult as each can be or may become a complication of the other.

The ideal treatment of true or idiopathic paralytic ileus is prophylactic. Preoperative cathartics are contraindicated. It should be unnecessary to mention them; even so there are still those who give preoperative cathartics. The preparation for surgery should not include an enema. Physical and psychic preparation of the patient are of too often unappreciated value. Gentleness in surgical manipulation, avoidance of trauma, careful hemostasis, and prevention of the lowering temperature must be kept in mind. As few surfaces as possible should be denuded of peritoneum which causes reflex

inhibition of intestinal movements. Gauze packing into the peritoneal cavity should at all times be avoided as it prolongs cessation of small bowel movement. Enemeta, pituitrin, aspirin, barbiturates, and atropine should be avoided in the early postoperative active stage of ileus. Adequate preoperative hydration, and normal body chemistry maintenance are excellent prophylactic measures. Nothing should be given by mouth until the nausea ceases. The stomach empties slowly the first 12 hours and the intestines do not move to enable absorption.

The early recognition of the signs and symptoms of ileus should indicate prompt adequate therapy. If the scout film shows gas in the small bowel, the abdomen is silent, and distention developing, morphine sulphate should be given every 4 hours. It produces duodenal spasms for a short while followed by relaxation. It decreases peristaltic movement in the duodenum and ileum but increases and maintains the tone and frequency of the small mixing waves. Morphine delays the passage of food and therefore causes constipation. An indwelling Wangensteen duodenal tube should be passed, for overdistention of the stomach causes loss of tone and decreased movement of the small bowel. Attention should be given to fluid balance and serum protein concentration.

If a fully developed irreversible ileus has developed the patient is very sick and the abdomen distended. Primarily, it should be remembered that true paralytic ileus is rare and it is a dangerous diagnosis to make. It may serve as a solace to pride, preventing the true diagnosis until too late for appropriate treatment. Correct in the diagnosis, passing of the Miller-Abbott tube or its like, together with replacement therapy, is the only way to save the patient's life. It is likewise the only means by which an overdistended bowel can be reduced in caliber (suction of a traveling ileostomy) to such a size that once more normal absorption from the loops of gut can be established. The success of the treatment hinges on the difficulty of introduction, care; patience; x-ray; for a large percentage never pass through the pylorus. In irreversible cases, its introduction should however not be delayed and even if it does not pass through the stomach it does no harm. Ileostomy having been proved of little value, if one is not successful in passing the Miller-Abbott tube, jejunostomy is recommended by Devine. It should be done as high as possible so as to empty the whole jejunum. A Miller-Abbott tube may then be passed through the jejunostomy and the patient fed through the jejunostomy tube.

No enema should be given until after the third postoperative day and no harm is done if one waits 5 or 6 days. Too many

enemas are given for no good reason. Hearing of borborygmi is not an indication for an enema. Stimulation of the large intestine by enemas also stimulates the small intestine even when the small intestine is isolated from the colon. If and when an enema is given it should be delayed until normal coordinated peristalsis has been established. Delegating responsibility to the nurses is not wise as a stimulating enema may precipitate a fully developed paralytic ileus. If one suspects the onset of ileus and peritonitis, prepare for it early by giving adequate morphine every 4 hours, reiterating the fact that morphine increases the bowel tone and mixing movements while decreasing the propulsive movements.

Various procedures and drugs are used oftentimes without an appreciation of their effects on the gastro-intestinal tract. Drugs generally used in the treatment of ileus may decrease intestinal movements and conduce to paralytic ileus. Atropine, in normal doses, causes inhibition of contraction and loss of tone of the small bowel. Hyoscine has an effect similar to that of atropine but weaker. Trasentine causes decrease in the small bowel movement, has no effect in relieving spasms and is of no value in intestinal colic resulting from adhesions due to plastic peritonitis. Adrenalin and neosynephrine slow contractions and decrease the tone of the intestine. Amylnitrite decreases both intestinal movements and intestinal tone. Barbiturates decrease the amplitude of intestinal contraction for 5 or 6 hours. Luminal, dial, seconal and nembutal decrease and may cause cessation of motility. Florey, Wright and Jennings observed that the secretion of mucus in the colon was decreased by barbiturates. Aspirin should never be given to an established paralytic ileus patient, as it decreases ileal peristalsis. Heat or turpentine stupes on the abdomen have no effect on intestinal movements. Oxygen therapy is of definite proved value as the intestinal gas volume is substantially reduced by means of its inhalation. Spinal anesthesia has a definite place in stubborn cases. Most authorities recommend prostigmine throughout in ileus. There is a low incidence of side effects, it maintains tone and the drug enhances peristaltic activity. Marked distention of the intestinal tract may cause decrease in the flow of bile. Bile administration into the intestine by mouth or through the Miller-Abbott tube increases intestinal motility. Penicillin and sulphonamides do not materially affect peristaltic movement and therefore should be administered as indicated. Thiamine chloride and B-complex should be given in sufficient amounts based on the findings of Leithauser.

Paralytic ileus, an infrequent entity, in reality, should be treated prophylactically, while intestinal movements are active, coordinated and responsive to stimulation and effective. A rational scheme of

active treatment for paralytic ileus is based primarily on early recognition, immediately followed by passage of the Miller-Abbott tube into the bowel creating a traveling ileostomy. Adequate morphine administration, apt attention to fluid balance and body chemistry are mandatory. Whole blood and plasma transfusions and the inhalation of pure oxygen complete the fundamentals of treatment. The incidence of paralytic ileus is low, its recognition frequently delayed, its treatment often postponed and the mortality too high.

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# EXPERIENCES WITH SPOOL COTTON SUTURE MATERIAL

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IN 1939 and 1940 Meade and Ochsner[1,2] reported the results of an extensive experimental and clinical investigation of spool cotton thread as a suture material. Comparing its properties with those of silk, linen and catgut, they found cotton superior in every respect. Other authors[3-7] have since contributed additional evidence of the merits of cotton. Some of its desirable qualities may be listed as follows:

1. Its pliability permits ease of handling.

2. Its tensile strength compares favorably with that of silk and catgut and, more important, it exhibits much less loss of strength when placed in tissue. (Cotton decreases 10 per cent in strength in 14 days, whereas silk decreases 35 per cent and catgut 50 to 75 per cent.)

3. It causes less tissue reaction and consequently interferes with healing less than silk and catgut.

4. Its compact structure prevents ingrowth of tissue, thereby reducing the incidence of suture sinuses sometimes produced by silk.

5. It is stable on exposure to heat or moisture and may be sterilized by boiling for 10 to 20 minutes or by autoclaving for 15 minutes at 15 pounds pressure.

6. Its high coefficient of friction permits the tying of reliable knots.

7. It does not produce allergic phenomena.

8. It is the cheapest and most easily obtained suture material.

9. Its use encourages meticulous surgical technic.

There has been considerable variation in the methods of preparation and use of cotton suture. Regardless of the method of sterilization, allowance must be made for shrinkage of the material. Thorek, Gradman and Glaess[7] cut the thread into desired lengths, clipped it to cardboard and autoclaved it for 10 minutes. Others advocate wrapping the material on rubber tubing, cardboard or other non-rigid material.[4] Hyde[6] described an ingenious method

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for preparing sutures with paraffined ends. Localio and Hinton,[3] in an exhaustive study to determine the type and brand of cotton best suited to surgery and the most efficacious method of sterilization, found that cotton decreases in tensile strength after autoclaving and increases after boiling if tested while wet. They concluded that cotton should be sterilized by boiling in water for 10 to 20 minutes and used while wet. Most writers have emphasized that cotton should be used according to the tenets laid down by Halsted[8] for the use of silk. However, experience has shown that the combined use of cotton and catgut is permissible[4,7,9] and that cotton is not only acceptable for use in contaminated or infected wounds but is considered by some authorities[4,6,10] to be the suture of choice in such wounds. Cotton has also been used double[7] and for continuous sutures[5] with satisfactory results.

For tying silk, Halsted[8] considered granny knots to be adequate. Ochsner[2] stated that reliable square knots could be made with cotton. More recently, Price[11] in an interesting study of the stress and strain of sutures and ligatures, found the only dependable knots to be those with three throws, the ends being cut 2 or more mm. long.

In January, 1947, Derbyshire[9] reported an incidence of 4.5 per cent late wound complications with the formation of suture sinuses or extrusion of knots in 372 carefully followed cases in which cotton suture material had been used. More than half of these complications were considered serious. Because of these complications, he had abandoned the use of cotton in contaminated or infected cases. The interest stimulated by that report led us to investigate the results obtained in our own cases.

## Methods and Material

This report is based on 560 operations in which cotton was used for suture material, performed by the authors at the University of Oklahoma Hospitals during 1947 and 1948. The series includes a wide variety of general surgical operations involving all regions of the body except the cranial cavity, anus, perineum and female pelvis. In most of the laparotomies, the peritoneum was closed with a continuous suture of chromic catgut; in the upper abdomen, the peritoneum and posterior sheath of the rectus were often closed together with continuous chromic catgut and reinforced with interrupted sutures of cotton. Chromic catgut was used for the mucosal suture in gastro-intestinal anastomosis and, in a few instances, for ligatures in the omenta and mesentery. Otherwise, cotton was the only suture material employed. Six-cord spool cotton (J. & P. Coats' and Clark's O.N.T.) was used in sizes No. 24 and No. 40 for fascial sutures; No. 40 for gastro-intestinal and skin sutures.

and No. 60 for subcutaneous sutures and ligation of small vessels. Large vessels were tied with No. 10. Transfixion ligatures were used only on vessels of medium or large size and fat-laden omenta and mesentery. All sutures were interrupted. One hand, three-throw knots with the ends cut about 1 mm. long were routine. For abdominal operations, transverse or oblique incisions were employed. Portions of bowel (4 cases), T-tubes (28 cases) and drains (117 cases including 45 abdominal) were brought out through the incision. Delayed or secondary closure was used in only 8 cases, 5 of them abdominal.

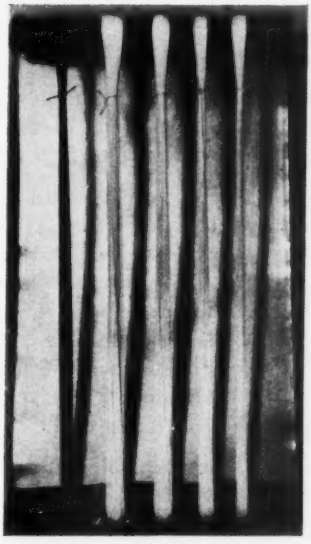

Fig. 1

For sterilization, the various size threads were wound on 7 by 4 inch sheets made of flexible stainless steel, bent at a right angle on one end and covered on both ends by sections of split rubber tubing to allow for shrinkage (fig. 1). The suture material was boiled in water for 10 minutes and used while wet. Uniform lengths of 15 inches are obtained by cutting the skeins of thread at one point.

Wounds were classified at the time of operation as clean, contaminated, or infected. Wounds of operations involving the opening or closing of any portion of the alimentary, biliary, urinary or respiratory tract were considered contaminated. Wounds of operations for acute inflammatory processes were classified as contaminated unless gross pus was encountered, in which instances, they

were listed as infected. Wounds made through a recently infected area and skin grafts applied to granulating surfaces were classified as contaminated. All other wounds were considered to be clean.

Wound complications were listed as hematoma, trivial infection, serious infection, wound necrosis and disruption. These terms were defined as follows: A hematoma is a sterile collection of blood or serum in or about the wound. A trivial infection is one which does not necessitate an increase in the length of hospitalization and which does not appreciably interfere with wound healing. Stitch abscesses are included in this group. A serious infection is one which interferes with wound healing or prolongs the period of hospitalization.

## Results

In the total number of 560 cases, there were 6 postoperative deaths. No follow-up was obtained in 17 cases. The remaining 537 patients were observed from 6 weeks to 2 years.

Of the 560 cases, the wound in 365 could be classified as clean, in 141 as contaminated and in 54, as infected. As shown in Table I, 7.6 per cent of the clean wounds became complicated, 2.7 per cent by infection. Complications in the 141 contaminated wounds amounted to 10.6 per cent, infection occurring in 7.8 per cent. Of 54 infected wounds, 22.1 per cent became complicated, 20.3 per cent by infection. The over-all incidence of complication was 10.1 per cent, the incidence of infection 5.7 per cent. Serious infection developed in only 4 cases, or 0.7 per cent.

An analysis of wound complications according to the type of operation or region of the body involved is presented in Table II. On consideration of each type of complication we find that trivial infections accounted for 50 per cent of the total complications. These infections were encountered in all types of operations. All of the four serious infections developed in laparotomy wounds, 2 in infected and 2 in contaminated wounds. Of these wounds, three were healed before the patients were released from the hospital; a suture sinus which developed in the other case healed following removal of two subcutaneous sutures 3 months after operation (Case 1, Table III).

Of the 21 wounds complicated by hematomas or necrosis, 18 were clean cases. Operations requiring skin flaps or grafts accounted for 19 of these complications.

Wound disruption occurred in 3 cases. The first case was that of a 76 year old white man with advanced arteriosclerosis, auricular fibrillation and cardiac failure, who was admitted with volvulus of

TABLE I. COMPLICATIONS RELATIVE TO TYPE OF WOUND

| Type of Wound | No. of Cases | Hematoma | | Trivial Infection | | Serious Infection | | Necrosis | | Disruption | | Totals | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Clean | 365 | 10 | 2.7 | 10 | 2.7 | 0 | 0 | 8 | 2.2 | 0 | 0 | 28 | 7.6 |
| Contaminated | 141 | 0 | 0 | 9 | 6.4 | 2 | 1.4 | 2 | 1.4 | 2 | 1.4 | 15 | 10.6 |
| Infected | 54 | 0 | 0 | 9 | 16.6 | 2 | 3.7 | 1 | 1.8 | 1 | 1.8 | 13 | 24.0 |
| Totals | 560 | 10 | 1.7 | 28 | 5.0 | 4 | 0.7 | 11 | 1.9 | 3 | 0.5 | 56 | 10.0 |

TABLE II. COMPLICATIONS RELATIVE TO REGION OF SURGERY

| Region of Surgery | No. of Cases | Hematoma | Trivial Infection | | Serious Infection | Necrosis | Disruption | Totals | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. | No. | % | No. | No. | No. | No. | % |
| Intra-abdominal | 170 | 0 | 11 | 6.4 | 4 | 0 | 3 | 18 | 10.5 |
| Hernias | 127 | 2 | 2 | 1.5 | 0 | 0 | 0 | 4 | 3.0 |
| Extremities | 115 | 3 | 7 | 6.0 | 0 | 4 | 0 | 14 | 12.1 |
| Miscellaneous | 62 | 0 | 5 | 8.0 | 0 | 0 | 0 | 5 | 8.0 |
| Thyroid | 31 | 1 | 1 | 3.2 | 0 | 0 | 0 | 2 | 6.4 |
| Breast | 29 | 4 | 1 | 3.4 | 0 | 5 | 0 | 10 | 34.4 |
| Skin Grafts | 26 | 0 | 1 | 3.8 | 0 | 2 | 0 | 3 | 11.5 |
| Totals | 560 | 10 | 28 | 5.0 | 4 | 11 | 3 | 56 | 10.0 |

the sigmoid colon. The involved bowel was gangrenous and there was diffuse peritonitis. An exteriorization type resection was performed. Evisceration occurred on the fourth postoperative day. The wound was closed with through and through heavy silk sutures. At necropsy 5 days later, the wound edges were covered with a fibrinopurulent exudate. The original sutures had cut through the fascia and peritoneum. The second patient was a 61 year old white man with a deep jaundice and ascites due to biliary cirrhosis. The operation consisted of exploration, cholangiography and liver biopsy. Evisceration occurred 5 days later. Again, the sutures had cut through the tissue. The wound healed following re-suture with heavy silk. The third disruption was in the wound of an emaciated white man of 71 who had advanced carcinoma of the body of the pancreas with invasion and obstruction of the third portion of the duodenum. Five days following anterior gastro-jejunostomy evisceration occurred and the patient died. At necropsy, most of the sutures had cut through the tissue.

Late wound complications are listed in Table III. In 537 wounds followed, there were 5 which developed suture sinuses or which extruded knots, an incidence of 0.9 per cent. None of these complications have necessitated hospitalization and all except one have healed. Of 124 cases of hernia repair followed, 2 (1.6 per cent) have developed recurrence.

## Comment

The incidence of wound complications with the use of spool cotton as reported in the literature shows considerable variation, doubtless due to the numerous factors involved in investigations of this type. As pointed out by Meade and Long[4] there are, in every large series of cases, certain instances in which wound complications are unlikely to be avoided regardless of the type of suture material employed.

After considering all the factors involved in the complications which occurred in our series, it was apparent to the authors that in almost every case, factors such as type of operation, general condition of the patient, avoidable or unavoidable contamination, failure to obliterate dead space, incomplete hemostasis, undue tension, etc., were of primary importance. Only in the 5 cases which developed suture sinuses or extruded knots could the responsibility for difficulty be attributed primarily to the suture material employed. Even in those cases, the roles possibly played by other factors cannot be disregarded.

Predisposing and exciting causes were prominent in each of our

TABLE III. LATE WOUND COMPLICATIONS

| Operation | Type of Complication | Remarks |
|---|---|---|
| 1. Drainage of psoas abscess | Suture sinus following trivial infection | Healed after removal of 2 subcutaneous sutures 3 months postoperatively |
| 2. Thyroidectomy | Innumerable knots extruded | Still extruding an occasional knot 6 months postoperatively |
| 3. Repair, traumatic rupture, urinary bladder; cystotomy | Suture sinus at site of suprapubic cystotomy | Healed following removal of one suture 4 months postoperatively |
| 4. Inguinal herniorraphy | Suture sinus following trivial infection | Healed after extrusion of one knot 6 weeks postoperatively |
| 5. Inguinal herniorraphy | Extrusion of 2 knots | Healed in 6 weeks |
| 6. Inguinal herniorraphy | Recurrence in 4 months | |
| 7. Umbilical herniorraphy | Recurrence in 6 months | Patient gained 30 pounds before recurrence |

3 cases of wound disruption. However, our exclusion of these complications from those due primarily to the type of suture material used may be questioned, particularly in view of the proved value of steel wire suture in preventing disruption.[12] Our main objections to steel wire are its lack of pliability, insecure knots, cost and radiopacity. Since the experience with the 3 cases of wound disruption reported, we have modified our technic of closure in cases predisposed to disruption. In such cases, we have used No. 8 or No. 10 cotton for fascial sutures, taking much larger bites of the fascia than usual, thereby hoping to prevent fascial sutures from cutting out of the tissue. The authors feel that this modification has prevented disruption in several instances.

## Summary and Conclusion

An analysis of 560 operations in which spool cotton was employed as suture material is presented The results obtained warrant the continued use of spool cotton for general surgical procedures.

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# INJURIES OF THE LARYNX AND TRACHEA

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THE neck, due to its location and poor skeletal protection, is quite often the site of traumatic injury. One of the most important complications of these neck injuries is associated injury of the trachea and larynx. Today it is thoroughly appreciated that these cases are best treated by an immediate tracheotomy, thereby permitting adequate surgical repair, or allowing edema and contusions to subside without apprehension of blockage of the airway.

Those cases in which there have been lacerations or puncture wounds of either the trachea or the larynx are best treated by thoroughly opening up the wound, minutely cleansing the tissues, and then repair of the opening of the airway with sutures. Occasionally a case may be seen in which there has been loss of tissue of the trachea to such an extent that closure by suture is not possible, or there has been such damage to the tissues that constriction and contracture are anticipated. In these cases we have felt a method of treatment could be used at the initial repair that has proved successful in our hands in connection with complications of just such cases, thereby decreasing the extent of complications and lessening the morbidity and disability.

Two cases of injury to the larynx have recently been completed. These cases were not seen initially by us, but later after fibrosis and scarring had ensued. The report of these cases will illustrate very well what could be done with the fresh injuries in which the fact was recognized that they would need reconstructive surgery later.

CASE 1. H. M., a 10 year old white male, was admitted to University Hospital on May 20, 1945, shortly after receiving a shotgun wound of the neck. He was treated for shock in the regular manner, then taken to surgery where a low tracheotomy was done. After this he was given an endotracheal anesthetic. The wound was explored and it was found that he had extensive loss of the soft tissues of the anterior part of the neck, baring the trachea and thyroid cartilage. The hyoid bone was fragmented and there were perforations of the pharynx and larynx. The wound was cleaned, the perforations closed and moist saline dressings were applied to the exposed tissues. Antitetanic serum, blood transfusions and penicillin were administered. Feeding was done by Levin tube.

We saw this case one week later in consultation in regard to the closure of the open wound (fig. 1). A skin graft was advised. One week later a split skin graft was applied to the upper portion of the wound, and the lower portion which was superficially infected was allowed to granulate in. The boy was discharged July 15, all healed but wearing a tracheotomy tube. When

the tube was plugged he spoke in a harsh whisper. From that date until Oct. 5, 1945, the patient had repeated dilations of his larynx. He continued to have dyspnea when the tracheotomy was plugged. It was finally decided that the scar and covering of the larynx was causing a restriction of motion and interference in expansion of the trachea. A pedicled flap from the anterior chest was then grafted after removing all scar tissue about the larynx. Patient was discharged Jan. 12, 1946, to be seen in the Out Patient Department. From then until Nov. 15, 1947, the patient had repeated dilations of the larynx, but the symptoms persisted.

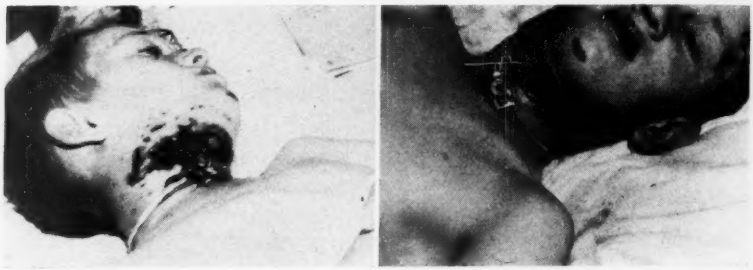

Fig. 1. Condition of patient when first seen.

On November 17, the patient's larynx was exposed by a transverse incision through the pedicled graft. The tracheal opening was enlarged, permitting an endotracheal tube to be passed down into the trachea, through which the anesthetic was given. Then the trachea and larynx were opened by a vertical incision. A thin band of scar tissue within the larynx on the lateral and anterior surfaces, one and one-half centimeters below the vocal cords was found.

This band of scar tissue was removed, thereby permitting the lumen of the larynx to assume normal size, but leaving a raw uncovered area of surface tissue.

An intermediate thickness skin graft was obtained from the medial side of the right arm. A piece of sponge rubber was then cut and shaped to fit into the larynx in such a manner that the larynx could be sutured around the rubber. This mold was then covered by passing a tubed penrose drain over it, as a glove finger over a finger. The skin graft which had been spread out on vaseline gauze with the external surface up, was lightly coated with rubber cement. The gauze and skin graft were then measured and cut to the pattern of the mold. This completed piece was then wrapped about the mold so that when the vaseline gauze was removed, the mold was completely covered in a vertical direction with a piece of skin presenting all around the raw surface of the skin, held smooth and in place by the cement.

After about five minutes, the mold and skin graft were placed in the larynx, and held in place by stainless steel sutures. These were placed by passing through skin, larynx and mold and out the other side in the same manner, being later attached to the tracheotomy tube. The larynx and skin were closed by interrupted black silk sutures. Vaseline gauze was placed in the lower end of the wound above the tracheotomy tube.

The patient reacted well and his convalescence was satisfactory. On November 30, the wire sutures and the rubber mold were removed. There was a good take of the skin graft. A wax impression was then made for the preparation of an acrylic mold to be worn until the period of shrinkage had ended (fig. 2). The rubber mold was replaced in the larynx.

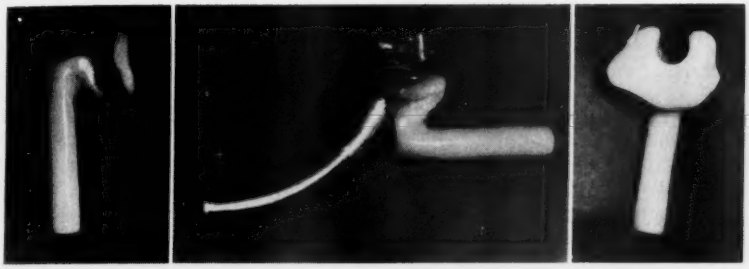

Fig. 2. Different views of obturator.

He wore the obturator (fig. 3) 6 months, when it was felt that the maximum amount of shrinkage had occurred. When the obturator was removed, the tracheotomy tube was likewise removed, and the wound was permitted to close by natural healing.

Fig. 3. Obturator in place.

Fig. 4. Condition of patient at time of discharge.

Patient returned 3 months later with a good voice, and a one-half centimeter opening into the trachea at the site of the old tracheotomy. Under local anesthesia this was closed by excision of edges and suture.

CASE 2. L. L., a 23 year old white male, was admitted to University Hospital Dec. 10, 1947. He had received a traumatic injury to his neck and

larynx in an automobile accident on Sept. 20, 1947. A high tracheotomy was performed by a local physician at the time of the injury. At that time, the patient was unable to speak and he was taken to Wichita, Kansas, where the high tracheotomy was closed and a low tracheotomy was done. The wounds of the neck gradually healed. It was necessary for the patient to continue wearing the tracheotomy tube. When the tube was removed and the opening temporarily closed, he could not speak or breathe. He was referred to University Hospital for treatment.

On December 12, the neck was explored surgically. There was dense scar tissue from the skin down through the muscles and about the larynx. The larynx was opened by a vertical incision, revealing complete obstruction of the larynx by the scar tissue which also involved the vocal cords. The scar tissue was excised, permitting the larynx to be realigned in the midline. A split graft was obtained from the left upper arm and placed over a sponge rubber stent. The stent was in turn fixed in position over the denuded area caused by excision of the scar by stainless steel wire traction sutures. The larynx was closed by stainless steel wire sutures. The tracheotomy tube was replaced and a vaseline gauze plug placed in the lower aspect of the laryngeal wound. The stainless steel traction sutures through the rubber stent were tied over a gauze dressing. A thyroid dressing was then applied over the incision.

Patient's postoperative course was satisfactory and on December 23, the stent was removed and an impression for an obturator made. The stent was replaced. The obturator was made from acrylic and was put in place on December 30. Patient was discharged on Jan. 7, 1948, with obturator in place, to be followed in the Out Patient Department.

He was seen in the Out Patient Department on Jan. 22, 1948, when the obturator was cleaned and tracheotomy tube changed. Progress had been satisfactory and there had been little drainage.

His progress was satisfactory and the patient was seen on July 20, 1948, in the Out Patient Department. He could breathe well when the tracheotomy tube was plugged. The obturator and the tracheotomy tube were removed. At this time the patient could speak in a deep throaty whisper.

He was followed in the Out Patient Department and it was noted that his voice was gradually improving, but the tracheotomy wound had not decreased very much in size. He was readmitted to the hospital and on Oct. 15, 1948, the tracheotomy wound was closed.

Patient was last seen in the Out Patient Department on Dec. 2, 1948. His voice had improved, but there still persisted a small fistula at the site of the old tracheotomy wound. He was asked to report in 3 months for observation.

## Discussion

Both of these cases had more than half of the circumference of the trachea rings intact. Such cases with the soft tissues replaced and kept open with a prosthesis until they have thoroughly healed in position would not show any decrease in the air passage. Those cases in which there have been losses of more than one half of the circumference or even complete loss of continuity would not be suitable for the procedures described, but would require some form

of rigid reconstruction using either cartilage, metal or acrylic as a framework.


## SUMMARY

Two cases of injury to trachea and larynx have been reported. The methods used in handling these cases would be applicable to fresh injuries of either the larynx or the trachea.


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# PRIMARY CARCINOMA OF THE LUNG

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## EARLY DIAGNOSIS LEADS TO BETTER SURGICAL RESULTS

During the past 15 years the field of thoracic surgery has developed with remarkable rapidity. Over this period various individuals, hospitals and clinics have accumulated a sufficient number of operated cases of carcinoma of the lung to permit accurate conclusions as to the diagnosis, treatment, prognosis and various factors affecting prognosis.

The apparent increasing incidence of carcinoma of the lung as reported in the literature, is impressive.[1-4] In 1944, as a cause of death, carcinoma of the respiratory system was exceeded only by carcinoma of the stomach, the uterus and the breast.[5]

The basic problem of cancer has not been solved. Contributing factors are known but the mechanism that changes so-called precancerous cells into actual cancer, or activates the precancerous potential inherent in each tissue, remains unknown. It is an established fact that cancer is curable, if recognized sufficiently early. Also, if the diagnosis of carcinoma of the lung is made early and adequate surgery performed, the chance for permanent cure is as good as in those patients operated for carcinoma of other organs of the body.

Although surgery for carcinoma of the stomach has a history twice as long as that for carcinoma of the lung, 5 year survival rates are reported as follows:

| *Carcinoma of the Stomach* | Per Cent |
|---|---|
| Lawrence[6] | 19 |
| Walters[7] | 24 |
| Custer[8] | 27 |
| *Carcinoma of the Lung* | |
| Ochsner & DeBakey[9] | 22 |
| Rienhoff[10] | 23 |
| Adams[11] | 23.5 |

There is still a wide gap between the number of cases of carcinoma of the lung that are recognized, diagnosed and treated early and the considerably larger number that are properly diagnosed too late for effective treatment.

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TABLE I

*Operability and Resectability in Primary Carcinoma of the Lung*

| Authors | Number of Cases Observed | Cases Explored | | Cases Resected | |
|---|---|---|---|---|---|
| | | No. | Per Cent | No. | Per Cent |
| Churchill | 156 | 52 | 33.3 | 27 | 17.3 |
| Burnett | 102 | 34 | 33.3 | 12 | 11.7 |
| Fetter | 31 | 6 | 19.3 | 0 | 0. |
| Overholt | 165 | 80 | 48.5 | 41 | 24.8 |
| Brock | 330 | 45 | 13.6 | 22 | 6.6 |
| Clagget and Brindley | 493 | 90 | 18.2 | 45 | 9.1 |
| Graham | 221 | 112 | 50.7 | 39 | 17.6 |
| Adams | 157 | 94 | 59.8 | 49 | 31.2 |
| Lindskog | 100 | 32 | 32. | 12 | 12. |
| Ochsner, DeBakey and Dixon | 360 | 210 | 58.3 | 129 | 35.8 |
| Jones | 196 | 78 | 39. | 39 | 20. |
| Total | 2311 | 833 | 35.6 | 415 | 17.9 |

A review (Table I) of 2,311 cases from the literature disclosed that only 35.6 per cent of the cases were explored. Excluding the few patients who would refuse surgery, it is reasonable to conclude that 2 out of 3 patients with carcinoma of the lung are clinically inoperable when diagnosed. Only 17.9 per cent of the 2,311 cases were resectable and 82.1 per cent were not diagnosed at a time when the disease was sufficiently localized to allow removal.

A review of the literature repeatedly implies the need for earlier diagnosis for effective treatment of primary carcinoma of the lung. Graham[12] states:

> It is desirable that every one who is having experience with bronchiogenic carcinoma should present his results because it is still necessary to indulge in a campaign of education of the medical profession about this disease. I do not share the pessimism which some others have. The only aspect that I am pessimistic about is the fact that in most cases the condition is not recognized early enough to do something for the patient. The fault is partly the patient's own, because he neglects to see his doctor. I am sorry to say, however, that the larger fault is with the medical profession who fail too often even to think of the possibility of the condition.

Physicians must be "cancer conscious," especially the physician in general practice for it is he who sees the patient first. The slogan of The American Cancer Society "If the patient is over forty think of cancer first" is well worth remembering. If we are ever conscious of the possibility of cancer, regardless of the complaints voiced, an infinitely larger number of cases will be recognized in time to reduce the mortality considerably. In addition to earlier

and more accurate diagnosis, the surgical result will be improved by exploration of some cases formerly considered inoperable, by more radical operation, by improved surgical technic and by reducing the postoperative mortality.

## Symptomatology

The clinical picture is not characteristic. The symptoms are insidious in onset and are essentially those of inflammation which explains the delay in diagnosis. The symptoms exhibited depend upon the size of the tumor as well as upon the degree of bronchial obstruction and ulceration. Any patient with a chronic cough or nonresolving pneumonia, or even a persistent and resistant simple bronchitis, warrants thorough investigation for possible pulmonary carcinoma. The diagnostic difficulties may be complicated by signs of pulmonary abscess due to necrotic changes in the tumor, blood-streaked sputum or even full fledged hemoptysis suggestive of tuberculosis. Also, a co-existing tuberculosis may mask the malignant disease of the lung.

Over 50 per cent of the patients will present the symptoms of cough, pain in the chest, hemoptysis, weight loss, previous respiratory infection, raising of sputum and dyspnea.

Cough is the most constant and persistent symptom. It is present in 90 per cent of the patients and is usually the earliest symptom. It is chronic and more or less continuous or it may occur in paroxysms. Expectoration may be mucous, purulent, or even blood-streaked and the amount is usually small.

Pain, the second most common symptom, occurs in approximately 65 per cent of the patients. It is most often due to pleural irritation from a tumor with a peripheral site or one that has spread to the periphery. It varies from discomfort and tightness or a characteristic pleuritic pain to the severe intractable type caused by tumor invasion of the intercostal nerves, or nerves of the brachial plexus. The location and type of pain also depends on the part of the pleura that is involved. If a tumor in the basilar portion of the lung irritates the diaphragmatic pleura, the pain will be felt in the area controlled by the distribution of the phrenic nerve. In some instances, eating will evoke pain only at the particular moment the peristaltic wave of the esophagus passes the diaphragmatic hiatus. When the tumor is located in the apex of the lung the initial stage of a Horner's syndrome may be the first indication or the patient may complain of a "rheumatic" pain in the arm. Occasionally, the pain is located between the scapulae. This may be evoked by scratching on either side of the thoracic vertebral column. When

the pain is due to pleural irritation, it disappears if an exudate appears and separates the pulmonary from the parietal pleura. The character of the pleural exudate in cancer is not specific. A sanguineous exudate may or may not be caused by carcinoma but it should certainly arouse suspicion. On the other hand, a serous exudate could be caused by cancer and therefore should not allay suspicion. Both should be centrifuged, stained, and studied for malignant cells.

Hemoptysis, varying from occasional streaking to fatal hemorrhage, occurs in about 60 per cent of the patients, and is dependent upon the amount of bronchial ulceration and infection.

Dyspnea may be due to pleural effusion, atelectasis or pneumonitis and varies with the extent of the process.

Weight loss is a finding often overlooked. It may be due to an accompanying infection or to advanced metastasis.

Previous respiratory infection, secondary to bronchial obstruction, has occurred in over 50 per cent of the patients. Frequently, occlusion of a bronchus by the tumor precipitates the initial symptoms. Slight wheezing occurs and unilateral wheezing is of considerable diagnostic significance because it is almost invariably the result of a lesion producing some degree of bronchial obstruction. Occasionally, through a ball-valve-like effect a peculiar localized emphysema may result but more commonly there is infection and localized atelectasis distal to the obstruction. The symptoms persist and a diagnosis of virus or unresolved pneumonia is often made. In males between the ages of 40 and 70, before such a diagnosis *is* made, the possibility of carcinoma of the lung should be carefully excluded.

Other less frequent symptoms are weakness, fever, and hoarseness, the latter indicating involvement of the recurrent laryngeal nerve.

In general, the symptoms are those of a slowly developing and expanding infiltrative pulmonary process, lacking in any specific symptom except, perhaps, persistent cough.

Carcinoma of the lung occurs predominantly in males. Most writers report a 70 to 80 per cent incidence in men.

## Roentgenology

Roentgenologic examination of the chest, the most important single diagnostic aid, is essential in every case of suspected pulmonary tumor. Unfortunately, the radiologist is confronted with difficulties similar to those of the clinician, there are no specific radio-

logic signs of carcinoma. There is wide, and sometimes confusing variation in the x-ray appearance of these lesions although most are radiographically recognizable to the cancer-conscious examiner. In all of the 327 cases reported by Rienhoff,[10] there was x-ray evidence of some abnormality. If the x-ray findings are not characteristic of one of the more common pulmonary lesions carcinoma must be excluded.

The tumor may be visible as either a central or peripheral area of density, sharply defined, or with radiating outer borders. There may be changes similar to those of inflammation such as abscesses and diffuse infiltration caused by necrosis of the tumor and secondary infection. Pleural effusion secondary to the primary tumor is also seen. Where there is obstruction of the primary or secondary bronchi resulting, x-ray signs are those of partial or complete obstruction; localized unilateral obstructive emphysema; linear, lobar or massive atelectasis; atelectasis with excessive fluid in the lung (drowned lung); localized bronchiectasis; inflammatory changes from secondary infection.

The diagnosis of carcinoma in the lung, as well as elsewhere in the body, cannot definitely be made by roentgenologic examination alone. The more experience one has the more accurate the interpretation. An infiltrating shadow, especially in the hilar region in the patient beyond 40 years of age, associated with persistent cough and hemoptysis, with no tubercle bacilli in the sputum, should be considered carcinoma until disproved.

Bronchography is helpful in selected cases, if bronchoscopy has not been an aid in the diagnosis and the tumor is not large enough nor of sufficient density to cast a shadow by ordinary roentgenologic examination. Injection of iodized oil may show a filling defect or bronchial obstruction.

The value of chest x-ray survey projects has been proved. Such surveys bring to light cases of primary cancer of the lung. These may prove to be the most readily curable if detected and treated before symptoms have developed and before the disease has proceeded to an inoperable stage.

## Bronchoscopy

Next in importance to the chest film in the diagnosis of pulmonary carcinoma is bronchoscopy. The only way of making a positive diagnosis prior to operation is by microscopic examination of a piece of the tumor. This may be obtained by bronchoscopy and biopsy, by study of sputum and secretions, and by aspiration biopsy. This latter method is condemned by a great majority of authorities

because of the danger of implanting metastases in the pleura and chest wall, as reported by Ochsner and DeBakey[4] and by Dolley and Jones.[13]

According to the literature diagnosis by bronchoscopy is accurate in from 50 to 80 per cent of all cases. The percentage of correct diagnosis varies with the location of the tumor, those in the upper lobe and periphery being less likely to be diagnosed by this method. However, a majority of primary pulmonary malignancies are in the bronchial segments visualized by bronchoscopy. In addition, narrowing, fixation and location of the tumor may be determined. This procedure may aid in determining operability. Also, retained obstructive secretions may be aspirated, thereby improving the patient's clinical condition before surgery.

### Cytologic Study of Sputum and Bronchial Secretions

In recent years the cytologic diagnosis of carcinoma of the lung on the basis of examination of sputum and bronchial secretions has gained much interest and developed to a gratifying degree of accuracy. Papanicolaou has done much to establish a sound basis for the cell smear method of diagnosing cancer. He has also pointed out that there is nothing new in this method. Cancer cells in the sputum were identified by Beale (1860), Sanders (1864), Quincke (1875) and Hampeln (1876). In 1935, Dudgeon and Wrigley[14] well described the method of cytologic examination of sputum. As the surgical treatment of carcinoma of the lung progressed and as Papanicolaou reported his work there was a rebirth of interest in the cytologic examination of sputum and bronchial secretions.

The value of this method in the diagnosis of cancer of the lung has been aptly demonstrated. Herbut and Clerf[15] in a study of bronchoscopically removed secretions demonstrated cancer cells in 73 per cent of the cases. In this same series a positive morphologic diagnosis from a study of tissue removed endoscopically was 36 per cent. In a later report[1] of 118 consecutive cases, by examining the bronchoscopically removed secretions, neoplastic cells were found in approximately 90 per cent of the cases. In the same group a positive biopsy was obtained by the bronchoscope in approximately 45 per cent of the cases. Neoplastic cells were found in 43 cases in which the bronchoscopic examination was completely negative. Watson[16] and associates reported results on 236 cases of proved bronchogenic cancer. There were 112 positive sputum reports and 29 positive bronchial washings and a positive cytologic diagnosis in 60 per cent of the cases. There were 176 bronchoscopies and positive biopsies were obtained in 37 per cent. Of these patients bronchoscoped, bronchial aspiration biopsies were done in 98, with

positive reports returned in 86 per cent. Strieder[17] reported positive smears in 74 per cent of 54 cases of bronchogenic carcinoma. McDonald, Harrington and Clagget[18] have 225 positive results among individual patients in a study of approximately 2,400 specimens of sputum and bronchial secretion, the vast majority of which have been specimens of sputum. They conclude that examination of both secretions and sputum should be done. Herbut and Clerf[15] believe that examination of bronchial secretions for tumor cells is superior to examination of sputum.

The efficiency of this method is dependent upon the skill of the endoscopist in obtaining secretions and the experience of the cytologist who examines the specimens. It is an adjunct to other diagnostic means in carcinoma of the lung and is particularly useful in cases where the tumor is located in the upper lobe and periphery. Early operable and curable cases can be demonstrated by this method.

## Exploratory Thoracotomy

In some patients it is impossible to establish definitely the diagnosis of pulmonary carcinoma without exploration. Exploratory thoracotomy, with present anesthesia and surgical technic, is accomplished with a minimum mortality and is as safe as exploratory celiotomy. If carcinoma of the lung cannot be definitely excluded by other methods, exploration should be performed. Of the 210 cases explored by Ochsner, DeBakey and Dixon[9] a positive preoperative diagnosis was established in 69.5 per cent of the cases. Lindskog[19] explored 20 of 32 cases without a positive tissue biopsy prior to surgery. Ten of the 12 resections he did in this series were operated without a positive preoperative tissue diagnosis. Four of the 31 patients operated by Gibbon[1] and associates did not have positive preoperative tissue diagnosis and 2 of the 4 were resectable. These facts support the use of exploratory thoracotomy in doubtful lesions.

## Treatment

Roentgen and medicinal therapy are only palliative and lung carcinomas as a rule are radioresistant. The disease is 100 per cent fatal when surgical extirpation of the involved area is not technically possible. Pneumonectomy is the most effective treatment for carcinoma of the lung. The incidence of recurrence following lobectomy is evidence that pneumonectomy should be done if possible. Formidable as the operation is, its technic has become so perfected that in the hands of a competent surgeon, its benefit should not be denied even to aged patients with pulmonary carcinoma. Patients, even in the seventh decade of life, have been successfully treated

by such radical surgery. This stresses the value of early diagnosis. Jones[3] reports an operative mortality of less than 4 per cent.

## Operability

Exploratory thoracotomy should be performed under the conditions listed previously and in all cases where the diagnosis is certain unless there is unequivocal evidence of extension of the disease beyond the hemithorax in which the tumor lies, or unless a pleural effusion exists which is bloody or contains malignant cells.

It is the feeling among most authorities today that the principles of radical cancer surgery are applicable to pulmonary carcinoma. Exploration is being done in patients with phrenic nerve palsy, involvement of the recurrent laryngeal nerve and those with continuous shoulder pain. These findings indicate an infiltrating growth which has extended beyond the confines of the lung. However, this does not mean that the lesion cannot be removed by block dissection including the involved nerve. Ochsner, DeBakey and Dixon[9] reported a patient with paralysis of the recurrent nerve, preoperatively, who survived 3 years after resection. The limits of operability have been increased in explored cases by more radical surgical treatment. Allison[20] proposed intrapericardial ligation of the pulmonary vessels. This procedure is being employed by most surgeons when it is effective in increasing resectability. In an effort to increase the limits of operability in cases explored Ochsner, DeBakey and Dixon[9] resected and sutured a portion of the auricle in 8 cases, resected a part of the diaphragm in 7 cases, and resected a portion of the chest wall in 6 cases.

## Operation

The operative technic has been described adequately by several surgeons and will not be discussed here. The decision to perform resection when the pleural cavity is opened is based upon the established principles of cancer surgery. If the primary lesion and all visible and palpable extension can be extirpated resection should be done. Pneumonectomy rather than lobectomy is the effective treatment.

## Pathology

Most authorities believe that carcinoma of the lung arises from the bronchial mucosa. They are classified microscopically, into three main groups; adenocarcinoma, squamous cell carcinoma and undifferentiated carcinoma. There also occurs a mixed tumor with both squamous cell and adenocarcinoma characteristics. Generally, these tumors are of a high grade of malignancy. Squamous cell carci-

nomas occur slightly more often than the other types and some authorities believe this type is best suited for surgical removal.

### Representative Cases

Case 1. A white male, 59 years of age, complained of a persistent cough of 8 months' duration. He raised very little sputum but on two occasions it was streaked with blood. He had anorexia and had lost 18 pounds in weight. He did not complain of pain in the chest. Figure 1 is the roentgenogram of his chest showing circumscribed infiltration in the left lower lobe. Bronchoscopy

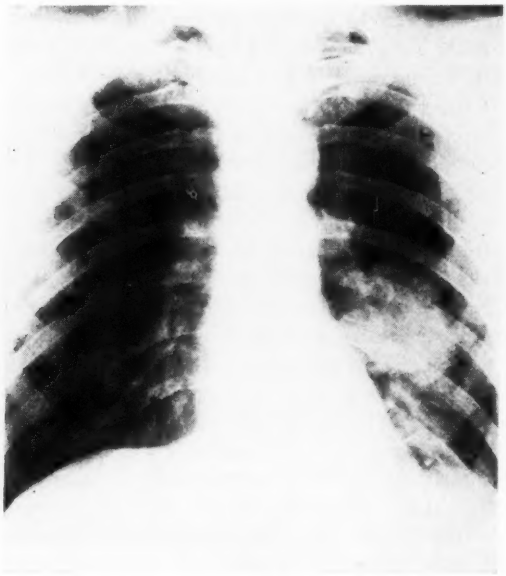

Fig. 1. Roentgenogram of chest (Case 1) showing circumscribed infiltration in left lower lobe.

revealed a lesion of the left lower lobe bronchus and the tissue removed proved to be squamous cell carcinoma. At operation there were no pleural adhesions and the lesion seemed to be limited to the lung. The left lung was removed with a dissection of the hilar lymph nodes. Microscopic study revealed no carcinoma in the lymph nodes studied. His postoperative convalescence was complicated by aspiration of water during a meal requiring bronchoscopic aspiration for relief. Otherwise, he had an uneventful recovery and has continued to improve 3 months after surgery.

Case 2. A white male, 42 years of age, fractured 3 ribs when he fell in December, 1947. Soon afterward he developed a cough which persisted. He had no other complaints. There was no weight loss, hemoptysis, dyspnea or pain in the chest. He had a chest film made in a mass survey and was asked to consult his doctor. This he did and the roentgenogram (fig. 2) revealed a

circumscribed infiltration of the right hilar region. Bronchoscopy revealed a tumor of the right main bronchus with no ulceration or obstruction. The tissue removed contained no neoplastic cells. Exploratory thoracotomy was done Aug. 2, 1948. The tumor seemed to be limited to the lung. A portion of the periphery was removed for frozen section microscopic examination. This tissue was malignant. A right pneumonectomy with hilar dissection was

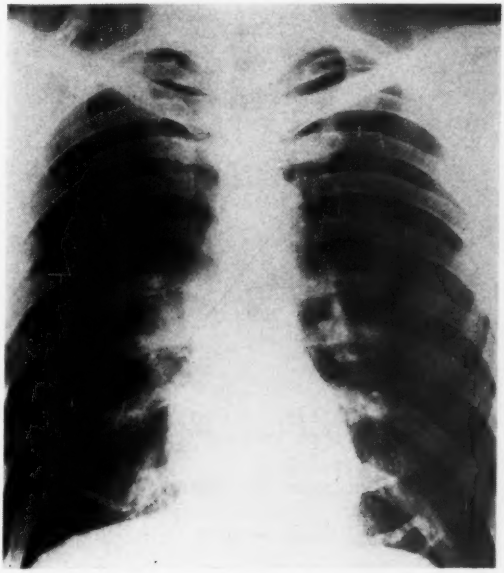

Fig. 2. Roentgenogram of chest (Case 2) showing circumscribed infiltration, hilar region, right.

done. Examination of the removed specimen proved it to be a poorly differentiated squamous cell carcinoma and the lymph nodes studied revealed no evidence of carcinoma. The postoperative convalescence was uncomplicated. He was examined 6 months after operation and there was no evidence of metastasis. He had gained weight and was in good physical condition.

CASE 3. A white male, 56 years of age, had had a cough for about 6 months, but denied raising sputum. There had been no weight loss, dyspnea, hoarseness, wheezing or pain in the chest. He had hemoptysis, raising about 100 c.c. of blood after a paroxysm of coughing. He consulted his physician who made a roentgenogram of the chest (fig. 3) which revealed a circumscribed infiltration of the left upper lobe and a fibrosis of the right apex. Tuberculin skin test and sputum examination for tubercle bacilli were negative. Exploratory thoracotomy was advised. At operation a carcinoma was found in the left upper lobe. There were dense fibrous adhesions from the upper lobe to the parietal pleura, more characteristic of fibrotic tuberculous adhesions than of extension of the carcinoma. Pneumonectomy with hilar dissection was accomplished. Examination of the removed specimen revealed squamous cell carcinoma with involvement of the lymph nodes in the malignant process. He

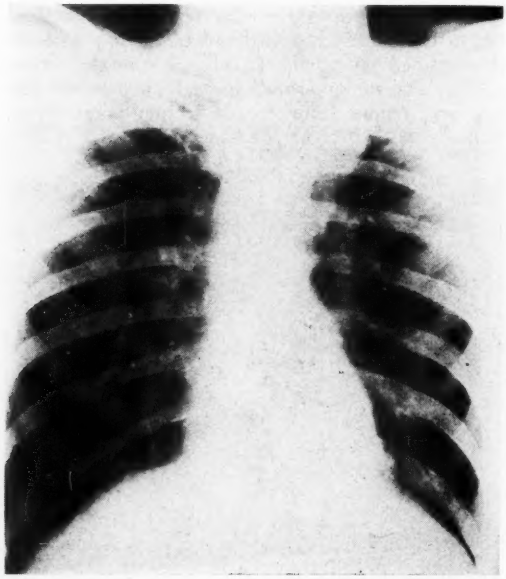

Fig. 3. Roentgenogram of chest (Case 3) showing circumscribed infiltration, left upper lobe, and fibrosis, right apex.

was given streptomycin postoperatively because of the evidence of the old tuberculosis. The postoperative course was uncomplicated and the patient continues to improve 2 months after surgery.

These cases represent relatively early carcinoma. Of course they have been operated too recently to make conclusions but they are presented to indicate what may be accomplished when the diagnosis is made while the lesion is resectable.

CASE 4. A white male, aged 53, had had symptoms for approximately one year. Nine months before the true diagnosis was established he was treated for "the flu." During the intervening months there were recurring episodes of fever, night sweats, dyspnea and anorexia. He had a chronic persistent cough sometimes productive of sputum. He was thought to have pulmonary tuberculosis but no tubercle bacilli could be demonstrated in the sputum. The roentgenogram made about one year after the onset of his symptoms is shown in Figure 4. This shows a diffuse infiltration of the right lower lobe resembling an inflammatory process. Tissue removed by bronchoscopy proved to be squamous cell carcinoma. At operation, the right lower lobe was adherent to the parietal pleura and diaphragm. Large lymph nodes were palpable in the hilar region. The right lung, hilar nodes and a portion of the diaphragm were removed. Microscopic examination revealed carcinomatous involvement of the lymph nodes. The postoperative convalescence was uncomplicated but slow. Six months after surgery there was no evidence of metastasis and the patient was doing light work.

CASE 5. This patient, a white male, 53 years of age, had symptoms 5 or 6

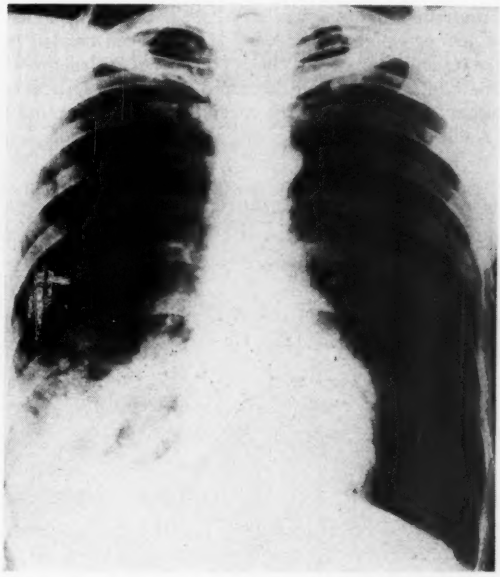

Fig. 4. Roentgenogram of chest (Case 4) showing a diffuse infiltration of right lower lobe resembling an inflammatory process.

Fig. 5. Roentgenogram of chest (Case 5) showing infiltration and atelectasis, right apex.

months before the true diagnosis was established. He complained of persistent cough, dyspnea, loss of weight and fever. He had been treated for virus pneumonia. The roentgenogram of his chest (fig. 5) revealed an infiltration and atelectasis in the right apex. Bronchoscopic tissue biopsy proved to be squamous cell carcinoma. At operation the carcinoma had infiltrated the chest wall and was firmly adherent to the mediastinal structures. The lesion could not be resected.

These 2 cases emphasize the importance of investigating for carcinoma of the lung the patient in the cancer age group with chronic pulmonary complaints and obscure x-ray findings.

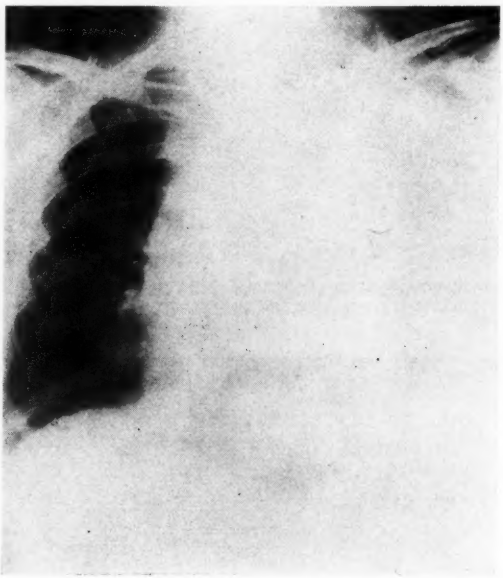

Fig. 6. Roentgenogram of chest (Case 6) showing a left pleural effusion and a soft tissue shadow in left supraclavicular region.

CASE 6. This patient, a white female, 62 years of age, had a pleural effusion when she first sought medical attention. She had a chronic unproductive cough, dyspnea, weakness and weight loss. Figure 6 is the roentgenogram of her chest showing a left pleural effusion as well as a soft tissue shadow in the left supraclavicular region. Biopsy of a supraclavicular lymph node revealed undifferentiated carcinoma. The fluid aspirated from the pleural cavity contained malignant cells. This patient was given x-ray therapy with no noticeable change in her physical condition. She expired 5 months after the diagnosis was established.

## SUMMARY

1. The incidence of primary carcinoma of the lung is increasing.

With early and adequate surgery a permanent cure is possible.

2. Eighty-two per cent of all carcinomas of the lung are not diagnosed when extirpation is technically possible.

3. The medical profession must realize its responsibility in diagnosing carcinoma of the lung when it is resectable.

4. The symptoms of cough, pain in the chest, hemoptysis, weight loss, raising of sputum, dyspnea and a history of previous respiratory infection are present in over 50 per cent of the cases. Seventy to 80 per cent of carcinoma of the lung occurs in men.

5. In males, between the ages of 40 and 70, with chronic pulmonary disease, the possibility of carcinoma of the lung should be carefully excluded.

6. Roentgenologic examination of the chest, the most important single diagnostic aid, is essential in every case of suspected pulmonary tumor.

7. Positive cytologic evidence of lung carcinoma may be demonstrated by bronchoscopic tissue biopsy, aspiration of bronchial secretions and by study of the sputum.

8. Exploratory thoracotomy is a valuable and accepted diagnostic procedure.

9. Surgical extirpation of the involved area is the only treatment offering a chance for cure. Pneumonectomy is the most effective treatment.

10. Surgical results can be improved by earlier and more accurate diagnosis, by the use of exploratory thoracotomy in questionable cases, by more radical operation, by improved surgical technic and by adequate postoperative care.

11. Early diagnosis is the most important factor in securing better surgical results.

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# TRAUMATIC STRICTURES OF THE EXTRAHEPATIC BILIARY DUCTS

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MANAGEMENT of a stricture of the bile duct is improving. Compared with the number of operations on the biliary ducts the number of traumatic strictures of the bile ducts is low. Factors contributory to operative injuries of the bile ducts are anatomic variations, inadequate relaxation and poor exposure. Many noteworthy contributions have been made to operative repair of the biliary ducts since a short-circuiting operation for obstructions of the bile ducts, a cholecystojejunostomy in 6 stages, was reported in 1882. The first successful choledochoduodenostomy was reported before the German Surgical Society at the Twentieth Congress in 1891.[1] The first successful hepaticoduodenostomy was reported by W. J. Mayo in 1905.[2]

The procedures adaptable to repair of strictures of the bile ducts may be classified into three groups. In the first group continuity is restored by direct anastomosis of the severed ends of the ducts or by implantation of the proximal segment of the duct or fistulous tract into the gastro-intestinal tract. In the second group mechanical devices are used to bridge the defect and restore continuity. In the third group viable tissue from various sites is utilized to provide a channel for the bile into the intestine.

Localized strictures of the common bile duct should be corrected by end-to-end anastomosis after excision of the strictured area. In a few instances, excision is not necessary when the stricture is a sharply defined ring-like area. Reconstruction may be accomplished over the proximal end of a T-tube after a longitudinal incision is sutured transversely. The T-tube is introduced through a separate incision in the common bile duct. The duct ends must be approximated accurately without tension. Fine non-absorbable suture is preferable. One layer of sutures is sufficient; these should be introduced in such a manner that no suture material projects into the lumen of the duct. The T-tube should be left in the duct for at least six months. Strictures of the distal end of the common bile duct may be circumvented by choledochoduodenostomy as reported by Sanders.[3] Direct anastomosis of the common bile duct to the duodenum is attended by better results when a reservoir of bile exists

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between possible intestinal reflux and the liver. A choledochoduodenostomy should be limited to strictures of the distal common duct.

Often the stricture is extensive with loss of duct substance. Every effort should be made to locate the distal end of the duct. As emphasized by Lahey,[4] the duodenum should be adequately mobilized to find the distal portion. Since the duct frequently passes through the substance of the pancreas, an incision into this organ may be necessary. When the distal portion of the duct is located by mobilization of the duodenum, it becomes feasible to anastomose between the duct ends. When the ends can be brought together without undue tension, direct anastomosis provides satisfactory results. More recently Allen[5] and Cole[6] have advocated the use of the Roux Y Arm procedure in strictures with extensive loss of duct substance.

The rubber catheter or T-tube has been most popular among the mechanical devices. According to Eliot,[7] Jenckel in 1905 and Sullivan in 1907 bridged gaps in the common duct with a rubber tube. Voelcker in 1911 placed a rubber tube into a hepatic duct and out of the duodenum externally with the serosal surface of the duodenal wall drawn around the rubber tube to the hepatic duct. Wilson[8] and later Dragstedt[9] used this procedure. Hicken, et al,[10] reported the use of an indwelling Levine tube for continuous decompression of the bile ducts after anastomotic procedures. Pearse[11] introduced the use of vitallium tubes to repair extensive damage to the bile ducts.

The reconstruction of the bile duct by viable tissue from various sites has been least successful. This approach probably has had as yet insufficient attention from the experimental worker. According to Walton[12] the appendix was suggested by Molineus in 1913; Davis and Lewis experimented with the use of strips of fascia in 1913; and Giordano and Stropeni implanted portions of a vein in 1914. Failure of these methods would seem inevitable, since a free graft is deprived of its blood supply and is subject to the action of bile. Search for a pedicle graft lead to consideration of the Fallopian tube. An adequate blood supply through the ovarian artery allows the Fallopian tube to be brought to the common bile duct area. The ability to heal after insult is well recognized. The sacrifice of normal function entails no additional risk to a sick patient. Preliminary studies in dogs favor the possible limited application in the human.[13]

During the preceding ten years 5 patients with traumatic strictures of the extrahepatic biliary ducts have been treated on the surgical services of the University of Oklahoma Hospitals. A brief resume of the problems encountered in the management of these patients is presented.

CASE 1. A white male, aged 53, had the first attack of severe epigastric pain during 1932. The pain radiated to the right scapular area. Two similar attacks occurred during the next year. Since that time an intermittent dull pain had been present in the right upper quadrant of the abdomen. There was no history of jaundice or of clay-colored stools. A diagnosis of chronic cholecystitis was made, and cholecystectomy was performed May 29, 1939. During the operation, a sudden marked hemorrhage occurred and during attempts to stop bleeding the common duct was injured. Postoperatively progressive jaundice, abdominal pain, and fever developed. The highest recorded icteric index was 131. Supportive treatment included the use of whole blood transfusions. The patient's condition rapidly became worse. During an exploratory laparotomy July 7, 1939, a diffuse continuous hemorrhage and numerous adhesions made the operation difficult and the operator was unable to isolate the common bile duct. A rubber tube drain was left in the area of the common duct. The patient died five hours following operation.

CASE 2. A white female, aged 56, had had pain in the right upper quadrant of the abdomen associated with chills, fever, nausea and vomiting in 1935. A diagnosis of cholecystitis was made and she recovered after 2 weeks of symptomatic treatment in a hospital. The next attack was in September, 1946, when she experienced a sharp pain in the right upper quadrant that radiated to the right scapula. The pain lasted for 10 days and was accompanied by nausea. She was admitted to the University of Oklahoma Hospitals on Dec. 26, 1946. After oral priodax the gallbladder could not be visualized. A G-I series and intravenous pyelograms revealed no abnormalities. On Jan. 13, 1947, a cholecystectomy was performed. The gallbladder was calcified and crumbled easily. There was a large gallstone in the cystic duct and the gallbladder was removed with great difficulty. Examination of the tissue removed at operation revealed a section of the common duct attached to the cystic duct. The patient became jaundiced and had abdominal pain. She refused further surgery and was discharged from the hospital on February 10. When seen July 30, 1948, she was deeply jaundiced. She had had several intermittent attacks of jaundice and abdominal pain. She refused further operative treatment.

CASE 3. A white female, aged 49, had a cholecystectomy in April, 1936, performed in another hospital. She was asymptomatic until October of that year when abdominal pain and jaundice, associated with clay-colored stools, developed. These symptoms persisted for approximately 2 weeks. Similar episodes occurred about every 6 months until August, 1948. Between attacks no symptoms were present. After August, 1948, attacks of abdominal pain and jaundice recurred each 3 weeks. She was admitted to the University of Oklahoma Hospitals Nov. 3, 1948. Right upper abdominal pain and jaundice were the chief complaints. Clay-colored stools and dark urine were noted. During the preceding 4 weeks she had lost 10 pounds in weight. Laparotomy on November 12 revealed a stricture in the distal portion of the common bile duct. The operation was technically difficult on account of massive adhesions, and the operative time was prolonged. A T-tube was placed in the common duct and the operation discontinued because of the patient's condition. During the postoperative course jaundice and abdominal pain continued. A postoperative cholangiogram revealed the contrast medium to be in the biliary fistula and none could be seen to enter the small intestine. A second laparotomy was done on Dec. 17, 1948. The external biliary fistula was lead-

ing into the proximal portion of the common duct. The fistula was connected to a loop of jejunum and a jejunojejunostomy was performed. The postoperative course was uneventful.

The patient was discharged from the hospital Jan. 1, 1949. Examination in the outpatient department on February 28 revealed no abdominal pain or jaundice.

CASE 4. A 36 year old white woman had had an attack of nausea, vomiting, abdominal pain, clay-colored stools and jaundice in 1938. After many similar attacks, in March, 1945, she became severely ill with fever, chills and jaundice. Her local physician performed a cholecystostomy and removed several gallstones. The gallbladder was perforated. Jaundice recurred. In September, 1945, she had a cholecystectomy. During operation a rubber tube was placed in the common bile duct and leading into the intestinal tract. She continued to have abdominal pain, jaundice, clay-colored stools and diarrhea. She was admitted to the University of Oklahoma Hospitals June 28, 1946. On July 9, 1949, she had a laparotomy. The subdiaphragmatic space was completely obliterated by dense adhesions. An anastomosis existed between the duodenum and the common duct. A stricture was high on the common duct. The liver appeared normal. Dense adhesions were present. The communication between the common duct and the second portion of the duodenum was separated by blunt dissection. Bile and gravel-like material were seen. The distal portion of the common duct had been transformed into a fibrous band. The bell-end of a number 18 Whistle catheter was placed in the common duct. Then the jejunum was divided about 12 inches distal to the ligament of Treitz and a post colic Roux Y Arm was formed. The jejunum was anastomosed to the common duct over the catheter. The catheter traversed the jejunum for a distance and the end was exteriorized by the Witzel procedure. The catheter was removed during the postoperative period. Following operation the patient gained 50 pounds. She developed epigastric pain, vomiting, dark urine, and clay-colored stools. A 1200 calory fat-free diet was recommended. During the next months no symptoms were present.

A letter was the last follow-up on Feb. 20, 1948. The symptoms suggested that she had cholangitis.

CASE 5. A white female, aged 28, developed epigastric pain radiating to the right scapular region in June, 1945. The symptoms recurred at weekly intervals. She was admitted to the University of Oklahoma Hospitals March 16, 1947. A laparotomy was performed March 31. The gallbladder was thickened and the lumen contained several calculi. A short cystic duct and pericholecystic adhesions were present. The common bile duct was normal. The cystic artery was inadvertently severed. Hemorrhage was controlled. The surgical specimen revealed cholecystitis, chronic, with cholelithiasis. A portion of the common bile duct was attached to the specimen. A stormy postoperative course followed. Bile drained from the incision. She was discharged from the hospital April 16. Frequent attacks of nausea and vomiting occurred. Stools were clay-colored. Jaundice developed. After she was readmitted to the hospital, a plastic repair of the common bile duct was performed Aug. 27, 1947. Dense adhesions filled the infrahepatic area. The liver was enlarged and mottled with light and dark brown lines. A stricture of the bile duct was located 0.5 cm. below the junction of the right and left hepatic ducts. The remainder of the supraduodenal bile duct was represented by a fibrous band. The stump of the common hepatic duct was opened. The

umbrella end of a No. 24 Fritsch mushroom rubber catheter was inserted into the duct. The opposite end was introduced in the duodenum. Postoperatively the stools were brown and the jaundice decreased. However, during the next year several admissions to the hospital were necessary. Abdominal pain, nausea, vomiting and jaundice characterized each attack. At laparotomy Aug. 23, 1948, dense adhesions included loops of small intestine in the infrahepatic space. The enlarged liver was deep green, mottled with brown lines. The bile duct was encased in fibrous tissue. The umbrella catheter was obstructed by precipitated bile salts. Paralleling the catheter was an internal biliary fistula. A vitallium tube was used to bridge the defect between the hepatic duct and the duodenum. The rubber catheter was not removed. Postoperative course was uneventful until Nov. 2, 1948, when epigastric pain, jaundice, white stools and dark urine developed. At laparotomy on Jan. 3, 1949, dense adhesions were encountered. The liver was enlarged, slightly nodular, scarred and deep green. The umbrella catheter was present. The vitallium tube was absent. An antecolic Roux Y Arm 12 inches long was made. The jejunal mucosa was sutured to the liver capsule about the hilar duct. The patient was free of abdominal symptoms when seen in the outpatient department on Feb. 15, 1949. The icteric index was 20.

## Comment

Since most strictures of the extrahepatic biliary ducts are due to operative trauma it is well to reemphasize the factors which may prevent this accident. If relaxation is not sufficient time should be allowed to provide deeper anesthesia. The incision should be sufficiently long to permit the exposure necessary, to isolate and identify, separately, the cystic duct and the cystic arteries. After identification the main artery should be traced to the gallbladder, ligated, and divided first. The extrahepatic ducts should be visualized before ligation of the cystic duct. In this manner the existence of any anomaly of the extrahepatic structures is recognized. Unexpected hemorrhage, as in Case 1, may be controlled by digital compression of the hepatoduodenal ligament. Gradual release of pressure usually discloses the bleeding point and allows clamping under direct vision.

An impacted calculus low in the cystic duct, as in Case 2, often obscures the junction of the cystic and common ducts. During removal, traction on the gallbladder may angulate the common duct. Unless each structure is identified before division, a segment of common duct may be removed inadvertently. In the presence of chronic cholecystitis with a thick-walled, contracted gallbladder densely adherent to surrounding structures, removal is more difficult. Isolation of the cystic duct is achieved by identification of contiguous structures and the removal of calculi from the gallbladder.

In a patient who is a poor surgical risk, as in Case 3, the flow of bile may be restored by anastomosing an external biliary fistula with

the intestinal tract as proposed by Von Steubenrauch[14] in 1906. The first successful such operation was accomplished by Williams[15] of Boston in 1914. Preservation of bile flow into the intestinal tract by this means has some disadvantages. Cicatricial contraction of the tract may lead to stenosis. Ascending infection frequently produces recurrent cholangitis. Probably only one in ten patients treated by this procedure remains well. If the condition is not permanently relieved it may be sufficiently improved to justify a more hazardous procedure.

Allen described the use of the rubber catheter to support the suture line when anastomosing the hilar duct to the Roux Y Arm as in Case 4. The catheter traverses the jejunal arm and is exteriorized. Removal is recommended after three months.

As in Case 5, the mushroom catheter may be completely occluded by precipitation of bile salts. An internal fistula was present around this catheter. The use of the umbrella catheter was reported by Montgomery[16] in 1947 in a series of 10 cases. Rubber tubes have three disadvantages: a marked foreign body reaction; tendency of spontaneous extrusion of the tube into the gastro-intestinal tract; and a high incidence of precipitation of bile salts, causing the channel to become occluded. If a rubber tube is to be used the T-tube has several advantages: it may be removed after sufficient time elapses, and thus not act as a further excitant of cicatrization. If bile salts occlude a T-tube, its removal may leave a patent bile duct. At the second operative attempt in Case 5 a vitallium tube was implanted. Vitallium produces less tissue reaction. It is an alloy of cobalt, chromium and molybdenum which has been found to be inert in bones, joints and the brain.[17] At the third operative attempt the vitallium tube was not present. In 1946 Pearse[18] summarized the results of numerous surgeons working in this field. He reported that of 79 cases in which vitallium tubes had been used to support suture lines attaching the hilar duct to the duodenum itself, 42.8 per cent were considered failures. As represented in this case, the type of stricture in which only the hilar ducts remain is the most difficult to repair. Cole[19] has abandoned the anastomosis of the hilar duct to the duodenum and prefers the use of the Roux Y Arm of jejunum to bridge the gap. The mucosa of the end of the Roux Y Arm of jejunum is used as a graft in covering the raw area of the scarred liver at the hilus. The Roux Y Arm should be at least 12 inches long. In Case 5, the absence of most of the extrahepatic ducts, with only the hilar duct remaining, would probably have made the Roux Y Arm the preferable procedure at the first, instead of at the third, operative attempt.

## SUMMARY

The treatment of 5 patients with strictures of the extrahepatic biliary ducts due to operative injury is presented. Suggestions are made for the prevention, management, and repair of such injuries.


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# PSEUDOMONAS INFECTION OF THE MANDIBLE

## With Discussion and Case Report

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Herein is reported an instance of osteomyelitis of the mandible in which an encapsulated strain of Pseudomonas aeruginosa was isolated. It is believed that this is the first reported case in the literature in which this organism has attacked the skeletal system of man. The clinical and laboratory findings and therapy are of unusual interest.

### Encapsulated Strains of Pseudomonas Aeruginosa

Human infections with organisms of the genus Pseudomonas are comparatively rare. It has long been considered that the species P. aeruginosa was the only one of the genus pathogenic for man. It is described as forming neither spores nor capsules.[1] However, in 1927 Sonnenschein[2] described strains of P. aeruginosa which were encapsulated. These were isolated from a case of typhoid cholecystitis, while the patient was receiving antityphoid bacteriophage. Sonnenschein was of the opinion that the encapsulated strains were variants of the unencapsulated strain and that the variation was induced by the action of bacteriophage, and cited other workers who had observed the same variations in Escherichia coli and certain of the paratyphoid organisms. However, in 1947 Schwartz and Lazarus[3] reported the isolation of the capsulated strains of the organism from the urine of several patients with urinary infection. Marsh, Strenge and Stem[4] have reported one case of meningitis and one of pneumonia, both in infants, in which the primary cause of the disease was the encapsulated strain of P. aeruginosa. Recently it has come to the attention of one of us that an encapsulated P. aeruginosa was isolated from the stool of an infant with diarrhea.[5]

### Case Report

E. C., a well developed, well nourished 7 year old white boy, was admitted to Children's Hospital Jan. 29, 1948, for treatment of a persistent suppuration of the right jaw. In August, 1947, he had been treated by his local physician for what appeared to be a cellulitis and adenitis about the angle of the right jaw, attributed to an infected tooth. At that time, there was no roentgenologic evidence of osseous or alveolar infection or destruction. In addition

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to the usual therapy, the patient received x-ray (20 ma., 150 Kv., ½ copper and one aluminum added filter, at 50 cm. distance) to the right side of the neck and face. By October, the condition had progressed to a massive cellulitis and adenitis. With local moist heat, penicillin therapy and incision and drainage, the acute symptoms subsided, although a purulent discharge from the site of incision persisted. Later, a suspected tooth was removed. Between November 15 and November 19, because of continued drainage and increased inflammation and with no roentgenographic evidence of involvement of the right mandible, the patient received a total of 365 r. over the involved area. Although the acute symptoms again subsided, the purulent drainage continued. The area was reopened and curetted, with no report of any sequestra being found.

*Physical Examination:* At the time of admission, the child appeared well nourished, in good health, and in no pain. There was moderate limitation of mandibular movements and a purulent discharge from a fistula near the angle of the right mandible. Temperature and blood counts were not remarkable. The right cheek was swollen, soft, not inflamed and not tender. There was some increase in local heat. Slightly enlarged nodes were palpable behind the ramus and under the right mandible. There was no stiffness of the neck. When the mouth was opened, the mandible deviated to the right. The fistula at the angle of the right mandible was surrounded by granulation tissue.

Fig. 1. Lateral view of extensive destruction of ramus of mandible with multiple cystic areas present.

Smears and cultures were taken from within the rather large fistula, and penicillin therapy was started, pending a diagnosis. Radiographic findings on January 30 were considered not to be those of the usual case of osteomyelitis in that they disclosed evidence of multiple cystic cavities posterior to the lower right first molar. The angle of the mandible appeared malformed and the condylar portion of the ramus appeared markedly deformed or absent (figs. 1 and 2). Further studies with lipiodol showed the sinus tract to lead to the posterior portion of the ramus of the mandible (fig. 3).

*Clinical Course:* In spite of penicillin therapy, the drainage continued. The smears and cultures were not significant. On February 27, exploration revealed destruction of the posterior aspect of the ramus; no sequestra or

Fig. 2. Postero-anterior view of destruction of ramus of mandible.

Fig. 3. Lipiodol studies.

necrotic bone was found. For irrigation purposes, a No. 11 perforated catheter was placed deep in the wound with the free end projecting from a point anterior to the tragus of the ear (fig. 4). A tissue drain was placed in the old fistula near the angle of the mandible. Penicillin irrigations (2 c.c. of 500 units per c.c., 3 times a day) were continued until March 26, with little regression of the drainage. Tyrothricin irrigations (2 c.c. of .5 mg. per c.c., 3 times a day in conjunction with sulfadiazine Gm. 1 q.4 h.) were then instituted and continued until May 7, with no encouraging results.

April 4, the cultures revealed a growth of P. aeruginosa encapsulatus. Repeat cultures verified this report.

On May 7, "A pure culture of Pseudomonas aeruginosa encapsulatus" was reported. The encapsulated strain of the organism when grown on blood agar, produced colonies of a heavy mucoid nature, not unlike those of *Klebsiella*

Fig. 4. Perforated catheter in place.

Fig. 5. Improvement of remaining ramus.

*pneumoniae*. Gram stain preparations revealed gram negative, rod-shaped, motile organisms with a heavy capsule. The reactions of the organisms when grown for 24 hours were: of the carbohydrates tested, dextrose only was fermented and this with the production of acid only. Nitrates were reduced and indole was not formed. Litmus milk was peptonized rapidly with an alkaline reaction being noted. Coagulated serum medium and gelatin were both rapidly liquefied. When grown on a dextrose agar at room temperature, a soluble blue-green pigment was produced.

A virulence test, in which 3 c.c. of a washed broth suspension of the organisms injected intravenously into a 12 pound rabbit, indicated that the encapsulated strain was as highly virulent as the unencapsulated strains. Death of the rabbit followed injection within eight and one-half hours and was attributed to pneumonia with some evidence of meningitis.

The organisms when tested in vitro against penicillin, streptomycin, and sulfadiazine were found to be rather resistant. Penicillin in a concentration of 100 units per cubic centimeter did not inhibit growth. Streptomycin in a concentration of 500 units per cubic centimeter had no inhibitory effects, and 100 milligrams of sulfadiazine per cubic centimeter barely inhibited growth.

At this reported pure culture date (5-7-48), drainage remained approximately the same as on admission. At this time, all other treatment was stopped, the irrigation catheter removed, and streptomycin therapy (225 mg I.M. q.3 h.) was instituted.

On May 10, there had been no drainage for 48 hours. On May 18, the fistula was entirely healed and the patient was discharged as improved. On Oct. 10, 1948, follow-up examination revealed no tenderness, drainage, or adenitis and roentgenographic studies showed an improvement of the remaining ramus (fig. 5). The patient was discharged as cured.

## COMMENT

While this case presents an unusual site for this infection, the apparent response to streptomycin is not consistent with either our own in vitro studies or the experience of others with P. aeruginosa encapsulatus infections at other sites. However, we feel that the results obtained in this case justify further study of the efficacy of streptomycin in these infections.

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# SURGICAL TREATMENT OF THYROID DISEASE

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With the increasing publicity in both the lay and medical press concerning non-surgical treatment of diseases of the thyroid gland, it seems appropriate to reevaluate the indications and results of the surgical treatment of goiter.

Prior to 1943, surgery was the only successful treatment for toxic goiter. In that year Astwood[1] announced the use of thiouracil, which would control the signs and symptoms of this condition. This announcement stimulated much research and discussion of a medical means to manage hyperthyroidism without the necessity of surgical intervention. Methyl- and propylthiouracil have been an improvement over thiouracil in providing drugs with more effect and less incidence of toxicity.

Radioactive iodine has assumed an increasing prominence in the literature as a non-surgical means of treating diffuse toxic goiter. The results in cases reported by Chapman[2] reveal that 41 of 45 cases so treated responded satisfactorily. Other investigators have published similar results. The duration of these cures and the possibility of late toxic effects have been the subject of many interesting discussions.

Goiter, malignancy, and thyroiditis are the most frequent diseases of the thyroid gland encountered by the surgeon today.

## Nodular Goiter—Toxic and Nontoxic

During the past few years there has been a definite change in our attitude toward patients with nodular goiter. Formerly we recommended operation only for toxic goiter, or for those nontoxic ones that were causing pressure symptoms or growing rapidly. Occasionally a large goiter was removed for cosmetic purposes. It now seems to be evident that almost all nodular goiters should be removed. This especially applies to discrete nodules. The reason for this change in attitude is that patients who have these nodular goiters, in the majority of cases, will develop complications directly or indirectly associated with or aggravated by the goiter. A nodular goiter, if allowed to remain long enough, will eventually cause trouble. At least 50 per cent of these tumors will become toxic if left over a period of 7 to 10 years. Excluding the 50 per cent that

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are frankly toxic, there is a subclinical toxicity which, though not marked, is none the less disastrous if allowed to be effective over a long period of time. Chesky[3] has suggested that thyrotoxicosis and hyperthyroidism be differentiated, in that the former is a condition resulting from altered thyroid activity, the latter a result of excess of normal activity. These nodular goiters will undergo various degrees of degenerative change. There is impairment of blood supply, congestion, edema, cyst-formation, hemorrhage, calcification, infarction and necrosis.

While these patients may have normal or minus basal metabolic rates prior to operation, they are none the less benefited by thyroidectomy. Whether this condition is due to absorption of degenerated products, pressure on the great vessels of the neck and mediastinum or some hormone or substance other than thyroxin secreted by the gland, seems to make little difference if the clinical results continue to be what they are in our experience. The evidence in favor of removing a nodular goiter that is already toxic has not been seriously questioned in spite of the occasional reports favoring treatment by propylthiouracil or radioactive iodine. These goiters do not respond so well to propylthiouracil as do the diffuse type and remissions have not been so lasting. Radioactive iodine is not taken up by the nodular goiter, except in relatively few cases of hyperfunctioning adenomas. With the danger of carcinoma that accompanies nodular goiter, surgical removal seems the treatment of choice. Recurrence of nodular goiter following thyroidectomy is rare.

All discrete or solitary nodules of the thyroid gland should be removed surgically due to the high incidence of carcinoma, the low morbidity and practically non-existent mortality connected with this operation. Graham[4] stated that 92.4 per cent of carcinomas have their origin in fetal adenoma. Cole[5] reported an incidence of 7.2 per cent and Soley[6] found 16 per cent of carcinoma in solitary adenoma. In the younger age groups the incidence of malignancy in adenomas is higher, even though the degree of malignancy is lower in the individual tumor. Kennedy[7] found 19 per cent of the carcinomas in a group of patients under 14 years of age.

In our experience over a period of the last 10 years at the University Hospital, 596 consecutive goiters yielded 190 nodular goiters. The incidence of malignancy was 4.2 per cent. The percentage of cures in this group of cases is higher than is seen with practically any other type of malignant disease when they are operated early. The type of operation recommended is not a simple enucleation of the adenoma, but a removal of the entire lobe containing the nodule.

### Diffuse Toxic Goiter

At the present time this is probably the most controversial type of goiter as regards the type of treatment to be used. Since 1943 thousands of cases have been and are being treated with thiouracil, propylthiouracil and methylthiouracil, while several hundreds of cases have been and are being treated with radioactive iodine.

The majority of cases of this type are still being treated by proper preparation and subtotal thyroidectomy. In proper preparation of these patients, one must keep in mind the disturbed physiology of the body as a result of the hyperthyroidism and not limit his therapeutic consideration to whether or not to use an anti-thyroid drug followed by iodine, or iodine alone. The same may be said if one is to use an anti-thyroid drug or radioactive iodine to the exclusion of surgery. The disturbed physiology of the patient must be corrected at the same time by the use of every means at the physician's disposal in order to rehabilitate the patient.

Jackson[8] reported a series of 75 cases treated over a period of 6 to 12 months with propylthiouracil with a recurrence of symptoms following the discontinuance of the drug in all but 3 cases.

Patients having small diffuse goiters with mild hyperthyroidism or those with small recurrences following thyroidectomy may respond satisfactorily to medical management if an anti-thyroid drug is used. Those with larger glands and severe hyperthyroidism should be properly prepared and a subtotal thyroidectomy performed.

### Acute Thyroiditis

Acute thyroiditis is usually secondary to an upper respiratory infection, but may appear spontaneously. There is a moderate swelling of the thyroid gland, painful to the touch with local heat and at times reaction in the overlying skin. The pain may be localized to the thyroid or referred by way of the cervical nerve to the ear, jaw or occipital region. Temporary hoarseness and cough may be present due to irritation of the recurrent laryngeal nerve or edema of the larynx. It usually runs a rather mild course with slight elevation of temperature, malaise and loss of weight, due to the indisposition of the patient to eat because of painful swallowing. Some cases present signs of mild hyperthyroidism.

The treatment is symptomatic for relief of pain, small doses of iodine as is done in parotitis and also with the purpose of preventing or controlling the temporary hyperthyroidism. Sulfadiazine or penicillin may be indicated, depending upon the severity of the disease. King has reported excellent results from the use of thiouracil.

Suppuration, though rare, is treated by incision as in the ordinary abscess.

### Chronic Thyroiditis

Riedel's struma is characterized by a gradual, not too painful, chronic inflammatory swelling of the thyroid gland which invades the capsule of the gland and involves the contiguous structures of the neck. DeCourcy[9] believes that this disease is caused by a non-bacterial perithyroiditis with a constriction of surface blood vessels. The symptoms are from tracheal or esophageal pressure due to the scarring and constriction which results. Relief is obtained only by surgical removal of enough of the gland to relieve the pressure symptoms. Due to the hardness and invasion of the capsule, a differential diagnosis from carcinoma can be made only by frozen section at the time of operation.

Hashimoto's disease or struma lymphomatosis of the thyroid gland is a disease of unknown etiology characterized by a gradual enlargement of a pre-existing goiter, although the patient may not have been aware of the presence of the goiter. This condition occurs mostly in females at or about the menopause which suggests some endocrine relationship. The microscopic appearance of the gland shows a replacement of thyroid acini by lymph follicles with germinal centers. There is no invasion of the capsule and the gland is softer than that characteristic of Riedel's struma. The symptoms are those of pressure. There is usually a bilateral symmetrical enlargement of the thyroid gland which is somewhat tender to palpation. Many patients show slight to moderate hypothyroidism.

Relief is best obtained by subtotal thyroidectomy and most of the patients require thyroid extract, postoperatively, to combat the resulting hypothyroidism. Biopsy followed by x-ray therapy has been recommended for this condition, but we have had no experience with this treatment. It seems possible that such treatment might well result in scarring and contraction producing more pressure symptoms after a sufficient time interval.

The surgical treatment of disease of the thyroid gland is an established, effective and safe method when in trained hands, and is the treatment of choice in the majority of cases.

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# CARCINOMA OF THE JEJUNUM

## Brief Discussion and Case Report

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Carcinoma of the small intestine, particularly the jejunum, is a rare pathologic entity. A review of the literature showed a wide difference of opinion as to the various phases of this condition.

The reported incidence varies considerably. Ewing's[1] estimate that 3 per cent of all gastrointestinal carcinomas arise from the small intestine is referred to by many authors, although most of them comment that this estimate is probably excessive in that their own incidence is lower. Mayo and Nettrour[2] report that .15 per cent of these malignancies occur in the jejunum and .47 per cent in the ileum. Christofferson and Jacobs[3] report a series of 90,892 autopsies in which 58 cases of carcinoma of the small intestine were found. Of these, the incidence of involvement of the duodenum was 26, jejunum 8, ileum 22 and in two instances the site was not determined.

The most common site of carcinoma of the small intestine has not been ascertained. Some authors state that carcinoma occurs "high"[4] in the intestinal tract. Maingot[5] and Warren[6] say "high and low, with the center area free." A report[7] of 41,838 autopsies performed at Vienna General Hospital revealed 10 cases of carcinoma of the ileum while none were found in the jejunum.

The average age of these patients varied from 60.8 years for the males, 53.8 for females[6] to an average of 43.9 years for both males and females.[8] A ratio of 2.5 males to 1 female was agreed upon.

It has also been agreed that symptoms referable to the gastrointestinal tract are of long duration but this may vary from a few weeks to years. In two isolated cases, gastrointestinal complaints dated back 20 and 27 years respectively.[6] These complaints are given as weakness, fatigue, indigestion, anorexia, weight loss, occult blood in the stools,[14] cramping abdominal pain, rumbling and borborygmi that may come late after eating, constipation that may progress to obstipation, nausea and vomiting, depending upon the height of the lesion and the degree of obstruction which may be absent, mild, or severe. Anemia was emphasized by Rankin and Mayo and others.[14]

These patients may have intermittent bouts of complete obstruction thought to be due to particles of food catching in the constricted

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lumen and then slipping through; others have sudden signs of an abdominal catastrophe due to perforation or permanent obstruction. A mass is sometimes felt upon physical examination which, according to Rankin, has a tendency to slip from beneath the fingers. It is agreed that only careful roentgenologic study makes the diagnosis possible and further development along this line will insure earlier diagnoses. The x-ray findings of dilated loops above the lesion, the demonstration of a filling defect, and a study of the mucosal pattern were stressed as important.[10] Two points were emphasized by Ross Golden:[11] that these tumor defects are of short length (4 to 6 cm.) while inflammatory lesions are longer (12 to 15 cm.) and that hypoproteinemia causes a marked abnormal segmentation and irregular distribution of the barium along the gastrointestinal tract.

The prognosis is poor. Some authors[8,5] state that metastases are slow but the high mortality results from a long delay in diagnosis and operation and the poor condition of the patient when surgery is undertaken. Others think that metastasis to regional lymph nodes, peritoneum, liver, lungs, long bones and dura occurs early.[4,12] The survival time is given as 17.6 months.[2] Rankin and Mayo[9] have no survivals of more than 3 years and Warren[6] states that 11 of 17 of his series had metastasis at the time of operation. Nine of these died in the hospital and 5 of those who left the hospital died within 2 years. It is agreed that the outlook of these patients is serious.[13]

A review of the records of 135,800 patients treated at the University of Oklahoma Hospitals, excluding carcinoid tumors and various sarcomas, revealed only 2 cases of carcinoma of the small intestine. In 1943, a carcinoma of the terminal ileum was resected in a 31 year old white male. The survival time in this case was 4 months.

A rather typical case of carcinoma of the jejunum is presented in the following report:

P. B., a 49 year old white male, was treated by the Medical Service of the University Hospitals from Feb. 4 to Feb. 20, 1946, for weight loss, cramping abdominal pain, nausea and vomiting of 7 months' duration, and constipation of 3 months' duration. Physical examination was negative except for weight loss, apparent anemia and a questionable mass in the epigastrium which, the patient stated, had always been present. X-ray findings at this time were interpreted as a probable lesion of the small intestine. However with treatment the patient became comfortable and the mass disappeared. He was discharged with the diagnosis of "possible lesion or polyps of the small intestine and gastritis," to return to the Out-Patient Department for further observation.

He was readmitted on 29 May 1946, with the same complaints, now worse at night. He had lost 30 pounds in weight since his discharge from the hospital and was very weak.

Physical examination showed a well developed, undernourished, markedly emaciated and anemic white male. A definite, non-tender mass, which did not move with respiration, was palpable in the right upper quadrant. Rectal examination was negative. A diagnosis of malignancy of the gastro-intestinal tract was made.

X-ray on 3 June: Stomach normal size with some upward displacement of the pylorus. Duodenal cap is smooth in outline and there is moderate increase in size of the duodenal loop with palpable tumor mass in this area. The second portion of the duodenum is narrowed.

Fig. 1. (6-3-46) G. I. Series, preoperative, shows upward displacement of pylorus, smooth duodenal cap with increase in size of duodenal loop. A palpable tumor mass was present in this area.

The patient was seen in consultation by members of the Surgical Service and a tentative diagnosis of tumor of the small intestine was made.

Laboratory work on this admission to the hospital was as follows: red blood count 2,750,000, white blood count 8,560, with a hemoglobin of 8 Gm. Total protein was 6.15 mg. per cent, albumin 4.5 and globulin 1.65.

Following multiple transfusions, restoration of electrolytic balance by parenteral fluids, chemotherapy in the form of sulfathalidine and a high carbohydrate, high protein, residue-free diet for 5 days preceding surgery, the abdomen was opened on 12 June and the following operative findings were noted:

"A hard, fibrous, nodular mass, napkin-ring in type, involving the small intestine about the junction of the jejunum and ileum, with extension to the

midportion of the ascending colon. Numerous soft nodes were palpable in the mesentery of the involved portion of both large and small intestine. The stomach, liver and remainder of the intestinal tract were essentially negative but it was noted there was quite definite dilatation of the proximal portion of the intestine above the tumor."

Fig. 2. Resected segment of jejunum, cecum and ascending colon. (Jejunum has been opened. Arrow points to tumor mass.)

A transverse incision was made with the concavity inferiorly with transsection of both rectus muscles. Resection 8 inches above and below the tumor site of proximal jejunum, corresponding mesentery and palpable nodes. The ascending colon was reflected medially and the lateral peritoneum was incised. The terminal ileum and up to the right half of the transverse colon were removed with the tumor and ileum. The ureter was preserved and the duodenum and retroperitoneal portion remained intact. End-to-end anastomosis of the jejunum with closure of the defect in the mesentery and a Lahey-Miculicz modification anastomosis of terminal ileum to the right half of the transverse colon was carried out. The terminal ileum was avascularized about 4 inches and a No. 32 Pezzer catheter, minus the bulb, was inserted to act as a spigot or safety valve for the first few days. A drain was placed in the lateral gutter after partial closure of the defect in the gutter. The wound was closed with 00 chromic continuous for the peritoneum, posterior fascia, and 00 silk, interrupted, was used for the posterior anterior fascia and skin.

*Pathologic Report: Gross:* The specimen consists of a resected portion of small intestine, mesentery, terminal ileum, appendix, cecum and ascending colon. The loop of intestine is 34 cm. long. In its central portion it is enlarged to a mass, 8 cm. in diameter, which is firmly adherent to the parietal peritoneum, touching the cecum. The terminal ileum is 7 cm. long. The appendix is delicate and is 5 cm. long. The cecum and ascending colon are 22 cm. long. The ascending colon contains pasty black-brown fecal material. The mucosal pattern is well preserved. No change is noted in the ileocecal valve. The proximal loop of small intestine is 3.5 cm. in diameter. The distal loop is 3 cm. It appears to be of a slightly smaller caliber than the proximal loop.

In the mesentery there is a firm mass, 5 by 3 cm.; on the cut surfaces this mass contains several gray-white lymph nodes. On the cut surfaces the mass is composed of neoplastic tissue interrupting the wall of the gut for a length of 3 cm. over the circumference, leaving a slit-like space between. The neoplastic growth is adherent to the cecum but does not penetrate its wall. Representative portion from the neoplasm and of the regional lymph node preserved for microscopic study.

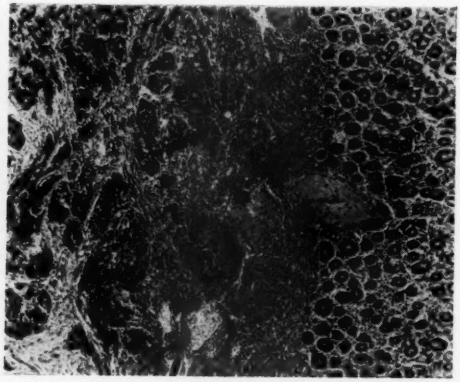

Fig. 3. Photomicrograph shows neoplastic cells invading and replacing submucosa and muscular coats of jejunum.

*Microscopic:* Sheets of neoplastic epithelial cells with some slight tendency toward individual cell keratinization are seen invading and replacing submucosa, muscular coats and serosa of the intestinal wall. Here and there, in the larger cell nests, there are areas of necrosis with a formation of acini or pseudo-acini. Some of the latter are lined apparently by cuboidal or columnar cells. In places the neoplastic cell nests are seen within lymph spaces. The cells have large, vesicular, deeply stained nuclei which vary in size, and some are seen in a state of division. In places the cells are mounted on connective tissue stalks. In another preparation acinar tubular structures, lined by columnar cells with several rows of cell nuclei, are discernible. Areas of necrosis and hemorrhage are frequent. Preparations from three lymph nodes show some slight increase of the connective tissue stroma, slight proliferation of the sinus cells, some exaggeration of the germinal centers of some of the lymph follicles, and no neoplastic involvement.

*Diagnosis:* Jejunum (resected segment) carcinoma, probably columnar cell. Terminal ileum, cecum with appendix and ascending colon (resected portion).

The postoperative course was smooth and the incision healed by primary intention. The spur was crushed and on 15 July the ileocolostomy was closed by the following procedure: Soap, water and alcohol preparation. Incision was made surrounding the ileocolostomy and carried down to the fascia. The wall of the intestine was carefully freed of all fat and several bleeders were encountered lying within this fat. These were ligated with 00 plain catgut. After the diameter of the bowel had been freed an Ochsner clamp was placed just beneath the skin level and the small border of skin and redundant mucosa lying above it was amputated. The bowel was then closed by a running locked

suture of 00 chromic, the Ochsner being removed slowly as the suturing progressed. This suture line was inverted with interrupted #40 cotton sutures. Sulfanilamide crystals were placed in the wound and a penrose drain was placed down to the bowel. The fascia was closed over the bowel. The skin was closed loosely with #24 interrupted cotton sutures. The peritoneum was not entered.

The wound healed without infection and the patient was discharged on 22 July. On return to the Outpatient Department on 22 Aug. 1946 the patient was symptom-free and had gained 20 pounds in weight. Check of his blood status revealed the following improvement: hemoglobin 13 Gm., red blood count 5,020,000, white blood count 11,800, total protein 5.6 mg. per cent.

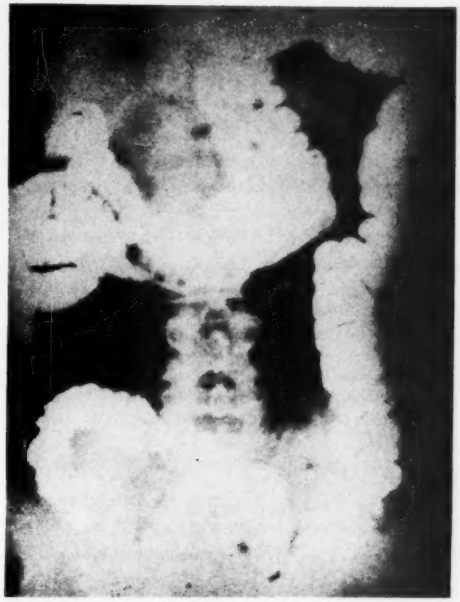

Fig. 4. (7-31-48) Postoperative barium enema. Shows no evidence of pathology of the colon and a good functioning ileo-transverse colostomy.

He has been followed in the Outpatient Department of University Hospitals periodically since surgery and was last seen on 3 Aug. 1948. He was without complaint, had gained some 50 pounds in weight, was the picture of health, and gastro-intestinal series on this date showed no pathology of the esophagus, stomach or duodenum. After 3 hours the stomach was completely empty. The head of the barium meal had reached the left side of the colon, indicating some degree of hypermotility of the gastro-intestinal tract. The site of anastomosis of the ileum to the transverse colon showed no evidence of pathology.

## Summary

Carcinoma of the small intestine is a rare pathologic entity. Excluding carcinoid tumors, approximately 300 cases of carcinoma of the jejunum and ileum have been reported in the literature. The present opinions concerning the diagnosis, prognosis, incidence and age groups vary in almost every article reviewed. This is probably due to the rarity of the condition which limits one's personal experience to a single case or two. Undoubtedly many cases have not been reported and we feel that only in submitting reports of every case encountered will such data become available for complete study and proper evaluation.


## Conclusions

1. A brief review of the literature has been given.
2. A case of carcinoma of the jejunum is reported.

Gross and microscopic diagnosis was made by Dr. Béla Halpert, Department of Pathology, The University of Oklahoma Hospitals.

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# CONGENITAL PYLORIC STENOSIS

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ALTHOUGH an analysis of the cases of congenital pyloric stenosis operated in St. Anthony and the University of Oklahoma Hospitals during the past 13 years reveals no new or outstanding developments, it affords an interesting recapitulation of data concerning the most common condition requiring surgery in the first few weeks of life.

*Definition.* Congenital pyloric stenosis is caused by an enlargement of the pyloric muscle, thereby occluding the lumen of the pylorus, and giving rise to symptoms of high intestinal obstruction.

*History.* The operation that is performed today for this condition was introduced by Rammstedt in 1912. Prior to that time the operation of pyloroplasty or gastro-enterostomy was performed, leaving in its wake a mortality of 50 to 75 per cent.

*Etiology.* The etiology of this condition is unknown at this time. It may be said that congenital hypertrophy and spasm of the pyloric muscle play a part in the pathogenesis.

*Pathology.* Grossly, the pyloric muscle is the size of an olive and of firm consistency. It does not retract when severed. Microscopically, there is hypertrophy of the circular muscle, and an increase in the number of muscle fibers.

*Symptoms.* There are five cardinal symptoms of congenital pyloric stenosis: Projectile vomiting, loss of weight and dehydration, visible peristalsis, and a palpable tumor in the right upper abdomen. If all are present, an x-ray examination of the stomach is hardly a necessity.

The onset of this condition is usually during the third week of life in a previously healthy baby boy. It begins with projectile vomiting with no bile in the vomitus. The child remains hungry and continues to nurse. He rapidly assumes the appearance of a little old man, due to dehydration and starvation.

*Physical Findings.* Peristalsis is visible in almost one hundred per cent of the cases. If the baby is observed for a few minutes, a mass can be felt in the right upper quadrant of the abdomen, in a majority of the cases.

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*X-ray Examination.* This may be used in cases in which all of the classical signs and symptoms are not present. If pyloric stenosis is present it will reveal an almost complete retention of barium 4 hours following administration. (Two ounces of barium may be given by mouth, in water or milk.)

*Preoperative Care.* This is extremely important and should not be hurried. It is the duty of the pediatrician to see that the fluid balance is established before operation is performed. Hartman's solution, plasma, blood transfusions, intravenous 10 per cent glucose are all valuable in establishing the fluid and electrolyte balance. Two or three days may be required to prepare these depleted children for surgery. Pyloric stenosis is *never* a surgical emergency.

*Operation.* The anesthetic of choice is local one per cent novocain infiltration. Open ether is preferred by many. If the stomach is distended it should be emptied by catheter. A high right rectus incision, 2 inches in length is used (either transverse or vertical). The liver is retracted upward and the pylorus is delivered into the wound. The tumor is held between the thumb and the index finger and incised by scalpel down to the mucosa. The handle of the scalpel is then used to separate the muscle fibers throughout its length until the mucosa bulges well. Bleeding may be controlled by hot packs or Gelfoam. The pylorus is then dropped back into the abdomen and the wound is closed in layers, using interrupted nonabsorbable sutures.

*Postoperative Care.* If there is no vomiting, some type of milk formula may be started 8 to 12 hours following operation. Attention is given to parenteral fluids until the baby is taking an adequate amount by mouth.

These babies should be under the care of a pediatrician during their entire stay in the hospital except for the time they are in the operating room under the care of a surgeon.

*Method.* All acceptable cases of congenital pyloric stenosis that were operated on from 1936 to 1948 inclusive at University Hospital and St. Anthony Hospital are reviewed from the standpoint of age, sex, duration of symptoms, presence of a mass, x-ray findings and mortality. There was a total of 119 acceptable cases: 87 from St. Anthony Hospital and 32 from University Hospital.

*Sex.* Eighty five per cent were males, and 15 per cent females. The average age on admission was 6½ weeks. The youngest age in the series was 5 days and the oldest 28 weeks.

*Duration of Symptoms.* The average duration of symptoms prior to entry to the hospital was 3.2 weeks; therefore, the average age of onset of symptoms was 3 weeks.

*Presence of Mass.* It was reported definitely "No" in 41 cases and "Yes" in 37 cases. If the record of the pediatrician stated that a palpable mass was present, credit was given for "Yes" even if the surgeon could not feel it, as the former is more in the habit of palpating these small abdomens.

*X-ray Findings.* X-rays were used in only 16 per cent of the total cases. It is interesting to note that the x-ray diagnosis coincided with the surgical findings in all but one case.

*Mortality.* The combined mortality for the 119 cases is 10.0 per cent (12 deaths). At St. Anthony Hospital the mortality is 9.0 per cent, and at the University Hospital it is 12.5 per cent.

In view of the mortality of 10.0 per cent it is of interest to note that Cante and McNally[1] report 30 cases with a 6.6 per cent mortality. Ladd et al[2] report 557 cases with a 0.89 per cent mortality. Nafe[3] reports 129 cases with a mortality of 1.5 per cent and Williams[5] of Melbourne, Australia, reports 400 cases with an 11.7 per cent death rate.

*Cause of Death.* Of the 12 deaths in this series, there were 5 autopsies.

I submit briefly the findings:

CASE 1. Death on the thirteenth postoperative day. Atresia of the colon found at autopsy.

CASE 2. Death on tenth postoperative day. Autopsy revealed peritonitis from perforation of the duodenal mucosa. Also, jaundice of the newborn.

CASE 3. Died 48 hours postoperatively. Autopsy revealed atelectasis.

CASE 4. Died 30 days after operation. Autopsy revealed recurrence of pyloric stenosis as the cause of death.

CASE 5. Died 10 days postoperatively. Autopsy revealed peritonitis due to perforation of duodenal mucosa.

There were no autopsies in the following 7 cases:

CASE 6. Died 14 hours postoperatively from respiratory failure.

CASE 7. Died 10 hours after operation of undetermined cause.

CASE 8. Died on eleventh postoperative day from vomiting and diarrhea.

CASE 9. Died 48 hours postoperatively due to shock.

CASE 10. Died 9 days postoperatively with abdominal distention. In this case the duodenal mucosa was opened at operation.

CASE 11. Died 5 days postoperatively with abdominal distention.

CASE 12. Died 11 days postoperatively due to malnutrition and circulatory failure.

*Postoperative Complications.* It is interesting to note that it was necessary to re-operate in 2 cases of this series for recurrence of the stenosis. One was re-operated 7 days and the other 30 days after the first operation. Both of these patients made uneventful recoveries following their second Rammstedt operation.

There was one wound disruption with evisceration on the sixth postoperative day; an uneventful convalescence following the second closure. (It was closed originally with absorbable suture and secondarily with non-absorbable suture.)

*General.* These operations were performed by a large group of surgeons. The classical Fredet-Rammstedt operation was performed in all cases. A right rectus muscle splitting incision was also used by the entire group. Ether anesthetic was used in the majority of the cases, either alone, or combined with local one per cent novocain. Local anesthetic alone was used in a minority of the cases.

## CONCLUSION

We believe that the total of 119 cases is enough from which to draw some definite conclusions. One will note that 85 per cent were male children. This is in line with other series reported.

The mortality of 10 per cent is high, when compared with other series reported over the United States. The duration of symptoms, which averaged 3 weeks before admission to the hospital, must certainly have some bearing on our mortality rate. The percentage of cases employing x-ray as an aid in diagnosis (16 per cent) is small, with only one of the reports revealing normal findings. We believe x-ray should be used more frequently as a diagnostic aid, especially when a mass cannot be felt.

The mortality of 12.5 per cent at University Hospital is high. However, the series is small. In our opinion 4 of the 12 deaths in the series can be attributed to surgical misadventures. Three of these babies had openings made in the duodenal mucosa at operation and the fourth apparently had an incomplete division of the muscle, as he died of pyloric stenosis 30 days postoperatively.

It is also of interest to mention that there has been only one fatality in the last 47 cases operated upon; a mortality of 2.1 per cent. We feel that this sharp decline is due, in part, to the use of antibiotics, but mainly to a more careful preparation of the patient for surgery through a better understanding of blood volume and electrolyte balance.

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# ACUTE OBSTRUCTION OF THE SMALL BOWEL

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THE rather recent remarkable lowering of the mortality rate attendant to acute obstructive lesions of the small bowel, is largely due to the clinical application of certain physiologic principles. The management of this lesion must be based on knowledge of the pathologic physiology incident to the obstruction, if the mortality rate is to remain low.

It is the purpose of the subsequent discussion to review briefly the physiologic principles involved in the management of acute obstructive lesions of the small bowel, and to present in some detail the results obtained at the University of Oklahoma Hospitals in 81 cases covering the 10 year period of Jan. 1, 1939 to Jan. 1, 1949. The survey includes acute obstructions, both partial and complete, occurring between the ligament of Trietz and the ileocecal junction, including intussusceptions of the ileocecal variety. Excluded from our study were obstructions secondary to external hernia, obstructions of a plastic nature such as occasionally occur shortly after major abdominal surgery or in the course of peritonitis, and cases secondary to generalized carcinomatosis.

## PHYSIOLOGIC CONSIDERATIONS

It is important to differentiate between the two main types of small gut obstruction:

1. *High Small Gut Obstruction.*

This lesion obstructs the duodenum or upper jejunum, and is characterized by profuse vomiting and early dehydration.

It has been estimated by Rowntree[1] that the average amounts of the various digestive juices secreted per day are as follows:

| Secretion | C.c. per day |
|---|---|
| Saliva | 1,500 |
| Gastric Juice | 2,000 to 3,000 |
| Bile | 300 to 500 |
| Pancreatic Juice | 500 to 800 |
| Intestinal Juice | 3,000 |

In this type of obstruction the vital digestive juices are prevented from reaching the highly absorptive bed of the ileum.

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In the later stages of this type of obstruction there is a rise in the non-protein nitrogen of the blood, the plasma protein level rises, and alkalosis may supervene.

The rapid loss of fluid and electrolytes by vomiting and lack of absorption, and the associated dehydration are the causes of death in high small gut obstruction. Hartwell and Hoguet[2] prolonged life in dogs with high intestinal obstruction for several weeks by administration of large quantities of saline solution subcutaneously.

Haden and Orr[3] showed a fall in the blood chlorides in experimental high small gut obstruction, and Gamble and McIver[4,5] demonstrated a loss of other ions besides chlorine, namely, sodium and bicarbonate, thus proving that the fall in essential plasma salts was due to loss of the digestive secretions of the stomach, pancreas, liver and intestine.

Therapy for this lesion should include constant gastric suction, adequate early parenteral replacement of fluid and chloride loss, and surgical relief of the obstructive mechanism after the patient has been satisfactorily hydrated.

2. *Low Small Gut Obstruction.*

Excluding the factor of strangulation, the progress of this lesion is a more tardy and complicated process. Vomiting is not as outstanding a feature as in obstructions affecting the upper jejunum or duodenum. The effects of the low obstruction are modified by the length of the obstructed segment as well as by the fact that some of the segment is resorptive in character. Replacement therapy does not greatly alter the length of life in the experimental animal with low small bowel obstruction.

When intestinal stasis has occurred, in a low small bowel area, progressive distention develops. The distention is due to an accumulation of gas and fluid in the obstructed bowel. The gas content arises from three sources:[6]

a. Swallowed air (68 per cent).
b. Gaseous interchange with blood circulating to and through the bowel wall (20 per cent).
c. Gas evolved from the action of intestinal bacteria upon the bowel content itself (12 per cent).

The fluid content is also largely derived from three sources:
a. Oral ingestion.
b. Fluid fractions from the blood secreted into the bowel lumen.
c. Fluid secreted by the digestive glands.

Crowley and Johnston[7] have summarized the mechanism of distention as follows:

1. Obstruction from whatever cause.
2. Stasis of intestinal content.
3. Progressive distention from fluid and gas.
4. Transudation of fluid and chloride into the bowel from the blood.
5. ($CO_2$ retention → Sodium excretion with water.
   (Water influx to blood from interstitial spaces.
7. Death.

That obstructive vomiting and abdominal pain are intimately related to the factor of distention, is well recognized. Associated also with distention are the marked increase in the bacterial count of the bowel content as well as a decrease in the effective circulating blood volume.[8-12] Furthermore it has been shown in experimental animals that excessive distention of the small bowel, suddenly induced, is capable of producing marked variation in the blood pressure and respiration of otherwise normal animals.[13]

As distention initiates these as well as many other harmful responses, it is obvious that the early control of distention is of primary consideration in these cases. Since Wangensteen[6,14-16] introduced the inlying duodenal suction tube in 1931, as a method of non-surgical decompression of a distended bowel, and Miller and Abbott[17] in 1934 developed a tube which can be made to reach any portion of the small bowel, rapid advances have been made in the successful therapy of small bowel obstructions.

3. *Strangulation Obstruction.*

Interference with the blood supply to the obstructed small bowel is the cause of death in the majority of cases. McKittrick and Sarris[18] reported that 59 per cent of the deaths in the patients with intestinal obstruction occurred in the strangulation group. Wangensteen[16] reported that 60 per cent of the deaths classified as related to obstruction were due to gangrene. In our series 9 out of 17 deaths, or 53 per cent, were proved either by operation or by autopsy to be due to gangrene.

The cause of death in intestinal strangulation is chiefly due to shock and peritonitis. Shock in this group of cases is probably a result of serious reduction in the volume of circulating blood.[19] Strangulation experiments in the dog indicate that as early as 4 hours after the establishment of strangulation, as much as a 25 per cent loss of circulating blood volume may occur.[19] Intubation will keep the gut above the strangulation decompressed, but will not

appreciably alter the changes in the bowel wall incident to the strangulation. It is the author's opinion that herein lies the greatest danger to the use of the long tube, i.e., unnecessary delay in attempting to manipulate the tube down to the point of obstruction in the face of impending or already present gangrene of the bowel wall.

Many authors such as Wangensteen,[6] McKittrick and Sarris[18,20] and Evans[19] have published reports dealing with differentiation between simple mechanical obstruction and that of strangulation in which the blood supply to the obstructing area is impaired. There is general agreement that early surgical intervention is imperative if there is any question as to the existence of strangulation.

## Statistical Review of Cases

As mentioned earlier in this article, the work here presented includes 81 cases of acute mechanical obstruction of the small bowel occurring in the 10 year period 1939 to 1949 treated at the University of Oklahoma Hospitals. The work represents the combined efforts of many surgeons on the staff, as well as the Resident and Intern Staff of the hospitals.

### *Mechanism of Obstruction:*

The fact that acute small bowel obstruction usually occurs at a single point and is most often due to bands or adhesions arising from a previous operation was pointed out by McKittrick and Sarris.[18] This is confirmed in our study. Table I indicates the various mechanisms which produced the obstructions.

TABLE I

*Mechanism of Obstruction*

| Cause of Obstruction | Number of Cases |
|---|---|
| Bands and Adhesions | 47 |
| Intussusception | 14 |
| Internal Hernia | 1 |
| Volvulus | 4 |
| Associated with Appendicitis (Abscess, Mucocele, Adhesions, etc.) | 5 |
| Congenital Bands | 2 |
| Meckel's Diverticulum | 1 |
| Meconium Ileus | 1 |
| Not stated or undetermined | 6 |
| Total | 81 |

### *Age:*

The average age of our patients was 31 years. The mortality rate in the various age groups is listed in Table II.

TABLE II

*Relation of Age to Mortality*

| Age (Years) | Number of Cases | Deaths | Mortality Per Cent |
|---|---|---|---|
| 0-10 | 18 | 6 | 33.3 |
| 10-20 | 6 | 0 | 0 |
| 20-30 | 11 | 2 | 18.2 |
| 30-40 | 17 | 2 | 11.8 |
| 40-50 | 18 | 4 | 22.2 |
| 50-60 | 2 | 1 | 50 |
| 60-70 | 7 | 1 | 14.3 |
| 70-80 | 2 | 1* | 50 |

*Patient refused surgery for 4 days.

McKittrick[18] has reported a death rate of 64 per cent in 22 patients 60 years of age or over. While our number of patients in this category is small (9 patients over 60 years of age) it is noteworthy that our mortality in this group was 22.2 per cent, and if the aged patient who refused surgery until he became practically moribund is discounted, the mortality rate for this group is only 12.5 per cent.

*Strangulation:*

Strangulation of the blood supply to a bowel segment is the major cause of death in acute small bowel obstructions. McKittrick[18] reported that strangulation obstruction occurred in 33 per cent of all cases. In our series strangulation obstruction occurred in 19 of the 81 cases reported, or 23.5 per cent; also 9 of the 17 deaths, or 53 per cent of our total mortality, was due to strangulation obstruction. Furthermore it is noted that 9 deaths occurred in the 19 cases of strangulation obstruction in our series, a mortality of 47.3 per cent.

*Type of Operative Procedure:*

The various operative procedures performed on the patients, and the mortality rates incident to each procedure, are presented in Table III.

Dennis[21] has advocated catheter enterostomy as the procedure to be adopted when conservative management of simple obstruction fails. The procedure advocated by Dennis is an aseptic one, placing the catheter in an emptied segment of gut after the Witzel pattern. He further reports a series of 18 cases in which catheter enterostomy was performed for simple small bowel obstruction. Of these 18 cases, 2 patients died from enterostomy

itself and 4 patients died from other causes after successful enterostomy. McKittrick and Sarris[18] have advocated catheter enterostomy under novocain anesthesia in those cases where decompression cannot be accomplished by intubation, and where laparotomy seems too hazardous. While the total number of cases in which we have used the catheter enterostomy is small, it is readily apparent from a study of Table III that our over-all mortality with this procedure is exceedingly high.

TABLE III

*Relation of Operative Procedure to Mortality*

| Operative Procedure | Number of Cases | Deaths | Mortality Per Cent |
|---|---|---|---|
| Enterolysis (Bands and/or adhesions) | 27 | 2 | 7.4 |
| Enterolysis and Reduction of Internal Hernia | 1 | 0 | 0 |
| Enterolysis and Suture of Perforations | 1 | 1 | 100.0 |
| Intussusception, reduction of | 10 | 3 | 30.0 |
| Resections | 8 | 3 | 37.5 |
| Volvulus, reduction of (Not requiring resection) | 3 | 0 | 0 |
| Enterostomy (alone) | 2 | 1 | 50.0 |
| Enterostomy and Lysis | 1 | 1 | 100.0 |
| Enterostomy and Resection | 1 | 1 | 100.0 |
| Drainage of Appendiceal Abscess and Enterostomy | 1 | 0 | 0 |
| Enteroanastomosis | 1 | 0 | 0 |
| Excision of Meckel's Diverticulum | 1 | 0 | 0 |
| Excision, Mucocele of Appendix | 1 | 1 | 100.0 |
| Total | 58 | 13 | 22.4 |

*Mortality:*

During the 10 year interval from 1939 to 1949, 81 patients suffering from intestinal obstruction occurring between the ligament of Treitz and the cecum were treated at the University of Oklahoma Hospitals. As mentioned earlier in this communication, cases which were excluded from this study were the following: (1) Obstructions secondary to external hernia, (2) early postoperative obstructions or obstructions arising in the course of peritonitis (these cases were treated by intubation) and, (3) cases arising secondary to widespread carcinoma.

Table IV lists some of the mortality rates which have been reported from various medical institutions and clinics throughout the United States.

TABLE IV

*Mortality Rates Resulting from Small Bowel Obstructions*

| Series | Year | Number of Cases | Mortality Per Cent |
|---|---|---|---|
| McIver—Mass. Gen. Hosp. | 1932 | 156 | 44 |
| McKittrick and Sarris—Mass. Gen. Hosp. | 1940 | 136 | 20 |
| Lewis, Shapiro and Vaughn—Cook County Hosp. | 1940 | 262 | 21.7 |
| Dennis and Brown—U. of Minn. Hosp. | 1943 | 48 | 14.2 |

The mortality rates in our series are shown in Table V.

The mortality study has been broken down into the two 5 year periods for comparison of progress in our management of these cases. There has, of course, been more liberal use of long intubation, chemotherapy, and blood during the more recent 5 year period. Furthermore the personnel available to administer care to those critically ill patients has been much more satisfactory during the last 5 year period, a fact which we consider of utmost importance in lowering the mortality. The 3 deaths which have occurred in the 34 cases treated from Jan 1, 1944 to Jan. 1, 1949 can be studied in the detailed death chart presented in Table VI. It will be noted that in one of these deaths (J. L. T.), the patient refused surgery until he became moribund 4 days after admission. In the second case, that of a 7½ month old infant (R. S.), there had been a previous admission to another hospital and reduction of an intussusception with barium enema. The intussusception recurred shortly prior to his admission to the University of Oklahoma Hospitals and an apparently unnecessary delay of 48 hours resulted before surgical intervention. In the third case (R. G.), the patient had suffered from obstructive symptoms for 14 days before admission to this hospital, was moribund on admission with apparently irreversible changes, and died 36 hours post admission.

TABLE V

*Mortality Rates for 2 Consecutive 5 Year Periods*
*(University of Oklahoma Hospitals)*

| Series | Number of Cases | Deaths | Mortality Per Cent |
|---|---|---|---|
| Jan. 1, 1939 to Jan. 1, 1944 | 47 | 14 | 29.8 |
| Jan. 1, 1944 to Jan. 1, 1949 | 34 | 3 | 8.83 |
| Total Jan. 1, 1939 to Jan. 1, 1949 | 81 | 17 | 20.98 |

TABLE VI – Data of Fatal Cases

| Date of Admission | Date of Death | Color, Sex, Age | Previous Abdominal Operation | Duration of Symptoms Before Admission | Hospital Delay Before Surgery (12 Hrs. or more) | Type of Obstructing Mechanism | Strangulation | Type of Operation | Autopsy | Postoperative or Post Admission Survival | Anesthesia |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5/11/39 | 5/14/39 | White, Female 48 | Yes | 3 days | Yes | Bands and Adhesions | Yes | Resection | None – (Peritonitis) | 24 hours | Cyclopropane Ether |
| 9/18/39 | 10/18/39 | White, Female 32 | Yes | ? | Yes | Old Adhesions | Yes | Enterostomy and Resection | None – Evisceration Fistula (pulm. embolus?) | 42 days | $N_2O$ – Ether |
| 3/ 5/40 | 3/17/40 | White, Male 44 | Yes | 28 hours | Yes | Adhesive Bands–Ileum | Yes | Enterolysis | Perforation – Ileum–Peritonitis | 9 days | Spinal Cyclopropane |
| 8/17/40 | 8/20/40 | Col., Male 68 | No | 4 days | Yes | Congenital Bands | Yes | Enterolysis and Suture of Perforations | Gangrene Perforations | 16 hours | Cyclopropane |
| 12/26/40 | 12/30/40 | White, Male 7 months | No | 30 hours | No | Ileocecal Intussusception | Yes | Reduction of Intussusception | Intussusception, Perforation, Cecum | 4 days | Ether |
| 1/31/41 | 2/ 4/41 | Col., Male 1 | No | 1 week | Yes | Ileocecal Intussusception | Yes | Resection | Peritonitis Pulm. Infarction | 24 hours | Ether |
| 3/ 4/41 | 3/ 5/41 | Col., Male 10 months | No | 36 hours | No | Ileocecal Intussusception | No | Reduction of Intussusception | Pneumonia–Shock | 12 hours | $N_2O$–$O_2$ Local Novocain |
| 3/24/41 | 4/15/41 | White, Male 51 | Yes | ? | Yes | Adhesive Bands | No | Enterolysis | Obstruction unrelieved–Pneumonia | 17 hours | Local Novocain |
| 4/28/41 | 4/30/41 | White, Male 20 | Yes | 7 days | Patient Moribund on Admission–No Surgery | Adhesions–Ileum | Yes | None | Gangrene, Ileum | 30 hours | None |
| 5/ 7/41 | 6/ 9/41 | White, Male 45 | No | 4 days | Yes | Bands – Ileum | No | Enterostomy and Lysis | None–(Peritonitis?) | 11 days | Local Novocain $N_2O$–$O_2$ |
| 11/18/41 | 11/19/41 | White, Male 6 months | No | 7 days | Patient Moribund on Admission–No Surgery | Ileocolic Intussusception (probably) | ? | None | None–(Peritonitis?) | 23 hours | None |
| 2/11/42 | 3/10/42 | White, Male 20 | Yes | 3 days | Yes | Bands and Adhesions | ? | Enterostomy | None–(Peritonitis?) | 26 days | Spinal |
| 8/ 1/42 | 8/ 1/42 | White, Female 38 | Yes | 4 days | Patient Moribund on Admission–No Surgery | Bands and Adhesions | No | None | Ileal Obstruction Mitral Stenosis | 11 hours | None |
| 1/ 3/42 | 1/ 7/42 | White, Male 9 months | No | 4 days | No | Ileocolic Intussusception | Yes | Resection | Peritonitis | 4 days | Ether |
| 7/23/45 | 7/31/45 | White, Male 79 | No | 19 hours | Patient refused Surgery for 4 days | Mucocele of Appendix | No | Excision Mucocele of Appendix | Peritonitis–Pneumonia | 4 days | Spinal |
| 8/11/45 | 8/13/45 | White, Male 7½ months | No | 7½ hours | Yes | Ileocecal Intussusception | No | Reduction of Intussusception | None–Shock | 1 hour, 40 minutes | Ether |
| 2/22/48 | 2/25/48 | White, Female 29 | Yes | 14 days | Patient Moribund on Admission–No Surgery | Bands and Adhesions | Yes | None | Perforation–Ileum Pneumonia | 36 hours | None |

Of the 81 cases reviewed, 58 cases, or 71.6 per cent, were treated by operation, with 13 deaths, or an overall operative mortality of 22.4 per cent, and 23 cases, or 28.4 per cent, were treated by non-operative methods with 4 deaths, or a mortality rate of 17.4 per cent. Only those patients who were considered too critically ill to withstand any operative intervention, and the milder simple partial obstructions were subjected to conservative therapy.

*Effect of Duration of Symptoms on Mortality:*

Many authors,[18,21,24-28] have stressed the relation of mortality to duration of the obstruction before admission to the hospital. Others, notably McKittrick, have shown that delay after the patient is admitted to the hospital is an important factor in mortality. Table VII shows the role which the factor of delay played in raising the mortality rate. In the group of 23 patients who were admitted before 24 hours after onset of obstructive symptoms there were 2 deaths. In one of these cases there was a delay of 4 days before operation, due to the fact that the patient would not consent to surgical treatment. In the second case, there was an apparently unnecessary hospital delay of 48 hours.

TABLE VII

*Effect of Duration of Symptoms on Mortality*

| Interval between onset of obstruction and admission | Number of Patients | Deaths | Mortality Per Cent |
|---|---|---|---|
| 0-24 hours | 23 | 2* | 8.7 |
| 24-48 hours | 14 | 3 | 21.4 |
| Over 48 hours | 35 | 10 | 28.6 |
| Undetermined | 9 | 2 | 22.2 |

*1 patient refused surgery for 4 days. In the second case there was apparently an unnecessary delay of 48 hours.

*Effect of Penicillin Therapy on Mortality Rate:*

It has been recently shown that penicillin will prolong the lives of experimental animals with strangulated ileal obstructions.[29] Because of the efficacy of penicillin in experimental strangulated obstructions, therapy with penicillin has been recommended[29,30] in all cases of acute intestinal obstruction in which strangulation is believed to be present or in which strangulation cannot be ruled out. It has been emphasized, however, by those advocating penicillin therapy, that this should be used only as an adjunct to early operation in such obstructions. While the number of cases in which we have used penicillin is small a marked lowering of mortality rate is noted (see Table VIII).

TABLE VIII

*Effect of Penicillin Therapy on Mortality in Acute Small Bowel Obstructions*

| | |
|---|---|
| Number of cases in which penicillin was used | 17 |
| Number of operations (all types) | 16 |
| Number of resections | 4 |
| Deaths | 1* |
| Mortality per cent | 5.88 |

*Patient J. L. T. refused surgery for 4 days after admission to hospital (see Table VI).

## Comment on Therapy of Acute Small Bowel Obstructions

When the history, physical examination and scout film of the abdomen have definitely established the diagnosis of acute small bowel obstruction, further therapy should be aimed toward correction of the disturbed physiology which has occurred as a result of obstruction. The author is in general agreement with McKittrick that immediate operation should be done on any case examined within 24 hours after the onset of symptoms, and that early operation is indicated in any patient seen in the second 24 hours after the onset of obstructive symptoms. Adequate salt, water, glucose, protein and vitamin requirements should be given, without delay, by parenteral administration. Measures to decompress the distended gut with a Miller-Abbott or similar tube should be instituted immediately on admission to the hospital, whether or not operation is contemplated. The liberal use of whole blood to prevent or combat shock, particularly in the patient with strangulation obstruction, is indispensable. Oxygen may be helpful in combating distention.[31]

There is enough experimental and clinical evidence substantiating the efficacy of large doses of penicillin to warrant its use, particularly in the strangulation cases.

Each case must, of course, be individually treated and no hard and fast rules can be unalterably set down. Delayed or even nonoperative treatment may be indicated in the poor risk or aged patient with marked distention in the absence of definite signs of strangulation obstruction. If conservative management should be undertaken, serial abdominal roentgenograms and careful frequent observation of temperature, pulse, abdominal signs and laboratory data are necessary. There should be no compromise in the management of the case with intestinal strangulation. Surgical intervention in this type of obstruction should be delayed only for treatment of shock.

## Conclusions

1. A brief discussion of the pathologic physiology incident to acute small bowel obstruction is presented.

2. Results of treatment of 81 consecutive patients with acute small bowel obstruction, treated at the University of Oklahoma Hospitals, during the 10 year period, Jan. 1, 1939, to Jan 1, 1949, are presented.

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# THE PLACE OF PATELLECTOMY IN TREATMENT OF FRACTURES OF THE PATELLA

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IT IS not my purpose here to discuss in detail the evolution of treatment of fractures of the patella. Nor do I intend to annotate a comprehensive bibliography of the multitude of excellent to indifferent articles on the subject. Rather will I attempt to point out the remarkable change in concept occurring within the past few years which has resulted in the unanimous inclusion of patellectomy as the treatment of choice in certain types of fractures. However, there remains a vast discrepancy between the opinions of surgeons as to the type and number of cases properly included in this category.

A brief survey of textbooks on fracture treatment is enlightening:

Wilson and Cochran, *Fractures and Dislocations,* 1928. The authors in this excellent textbook on the treatment of fractures and dislocations recommend: (1) Closed reduction of the fracture of the patella if not grossly displaced or comminuted; (2) open reduction for the badly displaced or comminuted fracture with careful replacement of all the fragments of the patella.

Campbell, in *Orthopaedic Surgery,* 1930, states that treatment of fracture of the patella is always surgical if the fracture is complete. Careful reposition and suture of all fragments is recommended. (He includes more cases in the surgical category than the prior reference.)

Magnuson, in *Fractures,* 1936, recommends: (1) Open reduction of *all* fractures of the patella if there is any displacement; (2) suture of *all* fragments into careful reapposition.

Phillip D. Wilson, *Management of Fractures and Dislocations,* 1938. This work is a compend of the work done at the Massachusetts General Hospital. It recommends open reduction of all fractures of the patella if the fragments are displaced. Careful attention is given to suture of the fragments, detailing several methods for suture using fascia, tendon, or different types of suture material.

Key and Conwell, *The Management of Fractures, Dislocations, and Sprains,* second edition, 1937, recommend open reduction of all fractures of the patella, if displaced, with careful suture. Here is mentioned for the first time removal of small fragments and suture

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of the patellar tendon to the remaining patella, two and a half lines being given to this method.

Campbell, *Operative Orthopaedics,* 1939 (1) urges operative treatment of all complete fractures with great detail of several methods of suture requiring accurate reposition of all the fragments; (2) discusses at some length the removal of smaller fragments with retention of a single large piece. This method is recommended for certain cases; (3) mentions patellectomy. Here is the first mention of patellectomy that I encountered in a standard text, a very cautious discussion of it, absolutely restricting its use to the very badly comminuted fracture which could not be treated by any other method.

Campbell, *Operative Orthopaedics,* 1949, advises: (1) Suture of the fragments if it is a simple transverse fracture; (2) removal of the small fragments and retention of the larger fragment, if there is a single large fragment; (3) patellectomy for comminuted fractures with displacement.

This represents a major change in operative treatment as advised in standard textbooks in the last 20 years. Textbooks must of necessity lag behind the current literature because of two factors: first, infrequent editions; second, and more important, their public. They must of necessity present the conservative, time-tested point of view.

Let us then abandon the textbooks and seek the current literature.

Occasional patellectomy for severe fractures has been reported as far back as 1890 (Althmann) or even possibly 1860. By 1909 Heineck was able to collect 10 cases. In spite of the severe nature of the fracture and fair results, he considered the method unsatisfactory. Many isolated cases were done with apparently satisfactory results, largely restricted to those cases where it was obviously impossible to carry out any other method. This would include, particularly, the badly comminuted fracture with displacement. Nevertheless, the method certainly did not receive popular support and the treatment of choice remained open operation with careful reposition of all fragments. Throughout this general period and until about 1935 great attention was given to various *methods* of repair with meticulous replacement of the fragments and fixation by catgut, kangaroo tendon, fascia lata, etc. For nonunion complicated methods of bone grafting were devised which certainly spoke well for the ingenuity of the various surgeons. Patellectomy was definitely not a part of the armamentarium of the surgeon treating the patella for fracture.

By 1935 Thomson and others presented material showing that

## PATELLECTOMY FOR VARIOUS TYPES OF FRACTURES

Cases selected from our files illustrating patellectomy for various complications about the knee and a few illustrative cases for comparison.

| Case | Name | Age, Sex | Diagnosis & Duration | Operation & Time | "RESULT" Range-Power-Pain | Grade | Comment |
|---|---|---|---|---|---|---|---|
| 1 | P. G. | 21 M | Comminuted fracture, 1-20-46. Operated and one large fragment retained. After 4 months the patient had pain, marked weakness. Motion 180-170°. | Patellectomy, 6-4-46 | 180-150. Good. No pain. | F | This patient should have had a primary patellectomy. The ill-advised primary operation followed by 4 months of scar formation and has resulted in restriction of motion. This should diminish. |
| 2 | J. J. | 22 M | Fracture of the patella. Wired 1-5-48. Refracture following minor injury 3-3-48, rewired. Pain, weakness. Motion 135-90°. | Patellectomy, 6-12-48 | 180-45. Good. No pain. | E | This patient had a fracture and two attempts at suture. He should have had a primary patellectomy. |
| 3 | J. P. | 56 M | Fracture of knee, 1932. Constant pain, weakness, loss of motion, extreme crepitation, knee locks. | Patellectomy, 3-16-48 | 180-60. Good. No pain, 6 mos. | G | Patient developed severe osteochondritis dessicans following damage to the cartilage subsequent to fracture of the patella with repair. Marked improvement following patellectomy. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | U. S. | 45 F | Fracture of the patella 7 years ago. Removal of fragments and suture to remaining pieces. Pain, weakness. Motion 175-145°. | Patellectomy, 3-25-48 | 180-60. Good. No pain, 1 yr. | G | This represents old neglected case with severe involvement of the patella. Weakness, pain, disability. Marked improvement following removal of the patella. |
| 5 | W. C. | 51 M | Fracture of the femur, 8-10-44. Nonunion, bone graft, etc. Resulting range of motion 180-115. 1-24--48 fell, receiving a comminuted fracture of the patella. | Patellectomy, 1-31-48 | 180-65. Good. No pain, 4 mos. | G | This patient volunteers that his knee was markedly improved following patellectomy, over his condition before the patella was fractured. Said he has greater strength, much better range of motion. No pain. |
| 6 | A. H. | 53 F | Comminuted fracture of the patella, 3-15-48. Multiple other injuries. Operation postponed until 3-30-48. Gross comminution and marked synovitis. | Patellectomy, 3-30-48 | 180-45. Normal. No pain. | G | From the appearance of this x-ray, it might seem that the proximal fragment could be left in. However, this type will easily tilt as the knee flexes. This lady had severe mental involvement from the skull fracture, and was able to take little or no physical therapy. Has a practically normal knee. |
| 7 | B.L.S. | 25 M | Multiple injuries 4-9-48. Comminuted fracture of the patella with removal of fragment and repair of tendon to large fragments 5-6-48. Nonunion, no active extension. Flexion 50-135°. | Patellectomy, 1-5-49 | 170-35. Normal. No pain. | G | This patient had an ill-advised repair, with resulting nonunion and severe disability. Primary patellectomy should have been done. |

PATELLECTOMY FOR VARIOUS TYPES OF FRACTURES—*Continued*

| Case | Name | Age, Sex | Diagnosis & Duration | Operation & Time | "RESULT" Range-Power-Pain | Grade | Comment |
|---|---|---|---|---|---|---|---|
| 8 | T. Y. | 52 M | Comminuted fracture distal half of the patella. Primary removal of small fragments and repair of tendon to large fragment. Test of function on table revealed tilting and patellectomy was completed at the same operation. | Patellectomy, 3-23-46 | 180-50. Good. No pain. | G | This patient illustrates better the rocking or tilting effect caused by suturing the tendon to too small a fragment. Test of function on the table revealed, as the knee approached a semi-flexed position, that the patella tipped forward and rested on the posteroinferior angle of the patella. |
| 9 | J. T. | 32 M | Severe comminuted fracture of the patella, complicated by table fracture of the upper tibia. Damage to the intra-articular structures. The patella was excised and lateral cartilage removed, tibial table replaced and held with Vitallium screw. Another injury postponed surgery 16 days. | Patellectomy, 9-9-47 | 180-75. Good Slight pain. | G | In spite of the serious complication of the fracture of the table of the tibia, which prevented early physical therapy, this patient had a very satisfactory result which could not have been obtained by patella suture. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10 | D. H. | 32 M | Giant cell tumor of the lower tibia with operation and bone graft, resulted in restriction of motion, 175-160°. Pain on motion and poor strength. Fracture of the patella 3 years post-operative. | Patellectomy, 12-6-46 | 180-125. Good. No pain, 2 yrs. | G | This patient's progress following the resection of giant cell tumor has been satisfactory and his complaint of pain has been in his knee, together with very little useful motion. Following patellectomy, he has improved motion, improved strength and much less discomfort. |
| 11 | Y. B. | 17 F | Compound fracture of the patella. Fracture of the femur on the same leg, 5-29-47. Excision of the patella. Traction for the fractured femur. | Patellectomy, 5-29-47 | 180-30. Normal. No pain, 22 mos. | E | The long immobilization of the fractured femur here would certainly have resulted in marked restriction of motion in the knee following any type of repair or fracture of the patella. Patellectomy results in normal joint motion. |
| 12 | L. T. | 38 F | Automobile accident, 9-21-46, multiple extensive injuries, including grossly comminuted fracture of the patella with gross displacement. She was seen 16 days after the accident with wide open wound. Excised patellar fragments, secondary closure. Fractured femur on same side. | Patellectomy, 10-8-46 | 170-45, Fair-good. No pain. | G | This patient's grossly compound, comminuted fracture with gross infection could hardly be treated in any other manner. Good result following patellectomy, in spite of long immobilization for the femur fracture. |

PATELLECTOMY FOR VARIOUS TYPES OF FRACTURES—*Continued*

| Case | Name | Age, Sex | Diagnosis & Duration | Operation & Time | "RESULT" Range-Power-Pain | Grade | Comment |
|---|---|---|---|---|---|---|---|
| 13 | L.C.H. | 45 M | Severe comminuted fracture patella, 10-13-46. | Patellectomy, 10-14-46 | 180-30. Normal. No pain. | E | Primary patellectomy resulted in prompt functional return of the knee. |
| 14 | L. H. | 14 M | Received comminuted fracture of the patella plus skull injury. Operation postponed because of head injury. | Patellectomy, 11-15-47 | 180-30. Normal. No pain. | E | This patient not only had fragmentation of the lowed pole of the patella, but linear fracture splitting the upper large fragment which would have resulted in chondromalacia had it been preserved. |
| 15 | A. R. | 60 F | Compound fracture of the patella, operated immediately. Had a clean compound wound. | Patellectomy, 7-16-49 | 180-45. Normal. No pain, 8 mos. | E | Had prompt recovery following compound comminuted fracture in an elderly person. |
| 16 | C.L.B. | 61 F | 1-31-49, badly comminuted fracture of the patella with gross displacement. | Patellectomy, 2-1-49 | 180-55. Fair. No pain, 6 wks. | E | Typical rapid recovery of function followed grossly displaced fracture in an elderly female. |

*From the file of Drs. O'Donoghue and Sell.

removal of the smaller comminuted fragments with suture of the tendon to one major remaining fragment was a distinct improvement over reposition and suture. This method had been used by many surgeons arising from the fact that severe comminution of the

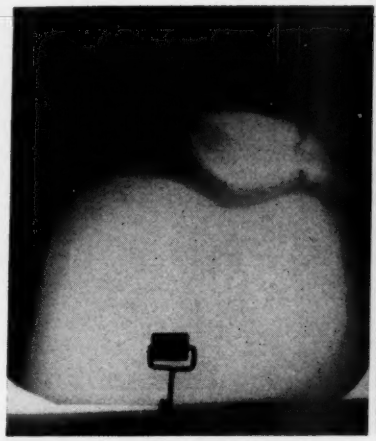

Fig. 1

Fig. 2

Fig. 1. E. W., 22, M. Typical fracture, lateral margin. Excellent result following excision of fragment only.

Fig. 2. D. B., 30, M. Case treated 10 years ago by careful reposition and wiring of fragments. Result one year later, marked restriction of motion (170-90).

small distal fragment made reposition difficult, if not impossible. Here then was the first major advance in the management of this fracture since the adoption of surgical repair. Technical improvements were many prior to this time. Here, however, was a change of concept which *advised* removal of fragments from *choice* rather than from *necessity*. Many, many reports filed in the next 10 years showed that morbidity, temporary disability, and permanent disability could all be lessened by eliminating the necessity for bony union and substituting union of tendon to bone. Rather than *shrinking away* from the fragmental lower pole, the surgeon learned to welcome this as the fracture which gave him the best results.

In the meantime, what about patellectomy? We have seen that as late as 1939 it was practically ignored in excellent textbooks. Not so in the literature. Many patellectomies had been done of necessity, but in 1937 Brook presented his revolutionary report in which he concluded that the patella was a phylogenetic remnant and that quadriceps function was better without it. He urged patellectomy for all fractures and presented good reasons to support this.

Here is the first all-out effort to recommend patellectomy as a treatment of choice and, as can be imagined, a controversy arose that is still teeming. Is the patella useful, or is it not? Should it be re-

Fig. 3

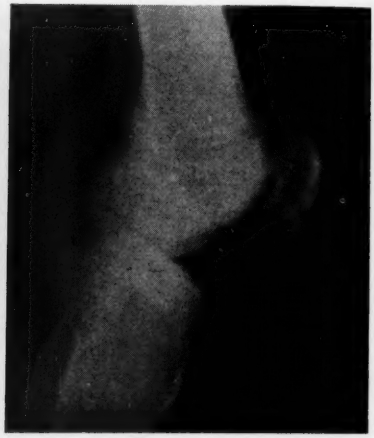

Fig. 4

**Fig. 3-4. H. C., 32, F. Transverse fracture patella, treated elsewhere by coaptation wiring. Position not good, illustrating the dangers of wiring transverse fracture through the middle third. Patient has marked disability.**

moved, or saved? Much experimental and clinical work was done with conflicting results.

Bruce and Walmsley in an exhaustive report of experimental work, especially on rabbits, concluded that the patella was an important element in quadriceps function and, too, that certain degenerative articular changes followed its removal. Others promptly countered that rabbits are not human and minimized the importance of either the mechanical advantage of the patella or of the degenerative joint changes following patellectomies.

In any event, patellectomy has become increasingly popular in the past 10 years. One has only to consult any of the annual compends (*Year Book of Orthopaedic Surgery, Progress of Orthopaedic Surgery,* et al.) to find article after article extolling the value of patellectomy until by 1948 it had taken its place alongside other methods of treatment with gradually increasing indications for its use.

What then has caused this rapid change in treatment of an age-old condition? In the first place, the place of open surgery in the treatment of fresh fractures has become assured. Careful asepsis, chemotherapy, improved anesthesia had laid the groundwork. The

Fig. 5

Fig. 5. R. H., 33, M. Most of articular surface intact. Excellent result following removal of fragments and repair of tendon to a single large fragment.

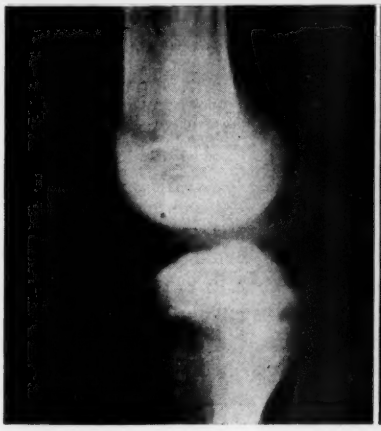

Fig. 6

Fig. 7

Fig. 6 & 7. (Case 1) P. G. Comminuted fracture. Ill-advised retention of one fragment. Motion 180-170, with pain in the knee. Patellectomy completed. Four months later, range 180-150, no pain.

qualified surgeon need no longer apologize for opening a fresh fracture. This is only the groundwork, however. There has come a gradually increasing demand for perfection of results in fracture treatment which has made us examine our results more closely. To the layman one fracture is like another. We can no longer excuse our poor results by saying that "it was a tough one," etc. Our

mechanical age demands a knee joint with excellent function. We cannot say, as I note in one of the articles, that following patella suture, "result excellent; flexion 85°; disability none." Another important factor is the optimum time of operation. Invariably until a few years ago it was recommended that the operation should be

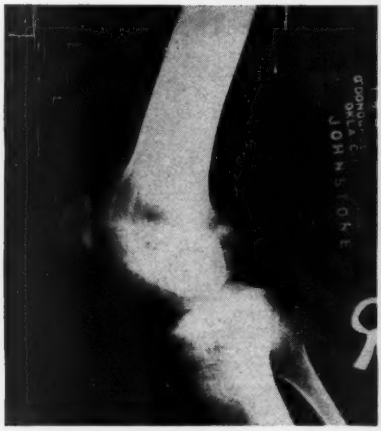


Fig. 8

Fig. 9

Fig. 8. (Case 2) J. J., 22, M. Two attempts at suture, 2 months apart, with non-union, pain, motion 135-90. Excellent result following patellectomy. Range 180-45, 3 months postoperatively.

Fig. 9. (Case 3) J. P., 56, M. Patella suture 16 years ago, following injury. Marked osteochondritis dessicans. Marked improvement following patellectomy. Old range 160-100, 6 months post-patellectomy 180-60. No pain.

postponed until "tissue recovery," at first 2 weeks, then 10 days, then 5 days. We now believe that *immediate* operation, if practicable, is preferable. Hence each case must be analyzed immediately and definitive treatment instituted then, or specifically postponed for some pressing reason. No longer is the waiting period automatic. This permits repair while tissues are fresh and elastic, before organization of blood in tissue, before edema. Patellectomy is incomparably easier and more physiologic when done immediately than when done after 7 to 14 days.

## Comment

One is struck, in reviewing the voluminous literature, that much of this controversy is based on a lack of a similar basic concept. Many opponents of patellectomy speak of the result in terms of a normal knee. However, the method is offered where, basically, the knee is already far from normal. The question is, "what method will offer the best percentage of good results?" Certainly there

may be some cases of degenerative change in the cartilage of the knee following patellectomy, but no surgeon can have thoughtfully observed the knee following trauma without realizing how very vulnerable the patellar cartilage is to even minor trauma. Observation of some hundreds of cases of intrinsic injury to the knee has

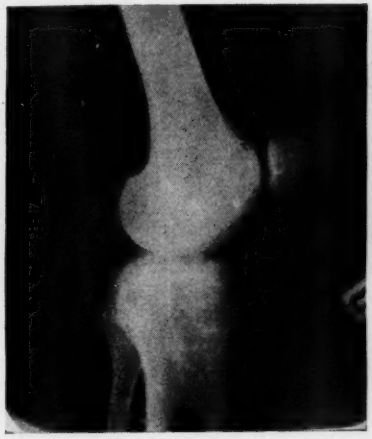

Fig. 10

Fig. 11

Fig. 10. (Case 4) U. S., 45, F. Fracture of the patella with repair 7 years ago. Patella should have been removed.

Fig. 11. (Case 5) W. G., 51, M. Patient with limitation of motion of the knee, from prior fracture of the femur. Knee motion improved after patellectomy following recent fracture.

convinced me that the patellar cartilage will stand but little change even in rhythm of motion, let alone direct trauma. Chondromalacia of some degree is present in the patella of a large percentage of knees opened for intrinsic injury, certainly well over 50 per cent. Considering those factors it seems that there is much more danger of degenerative change in the knee retaining an imperfect patella than in that joint in which the patella is sacrificed. Patellectomy in many cases promises a better knee.

## Summary and Conclusion

What, then, is our recommendation for treatment of the patella fracture? (1) The only fracture not demanding an open operation is the incomplete fracture without displacement. Even this fracture may develop chondromalacia of the patella and later require definitive surgery. Further statistical results will be necessary to determine whether or not these cases should be included in the group requiring patellectomy. (2) If the fracture is comminuted at one

Fig. 12

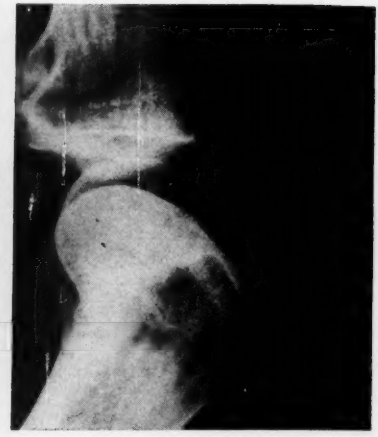

Fig. 13

Fig. 12. (Case 6) A. H., 53, F. If this type of fracture is treated conservatively, disability results. Removal of the lower fragments only cannot result in a smoothly functioning patella. Patellectomy must be done here.

Fig. 13. (Case 7) B. L. S., 25, M. Wide separation, with restriction of motion following inadequate repair of the tendon to the patella.

Fig. 14

Fig. 14. (Case 8) T. Y. Case operated March 23, 1946, with removal of lower fragments and suture to the upper. Wound closed. On test of flexion, the fragment tilted over and rode on the distal posterior edge of the patella. Reopened and patellectomy completed at the same operation. Result excellent.

or the other pole and the remaining intact fragment is at least two-thirds of the bone, removal of the fragments with suture of the tendon to the remaining large fragment may be chosen. After suture, if a check of function by flexing the knee reveals that the

Fig. 15

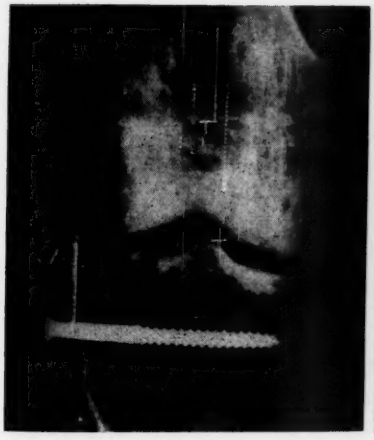

Fig. 16

Fig. 17

Fig. 15, 16, 17 (Case 9) J. T. Comminuted fracture patella, fracture outer table of the tibia with good result following patellectomy and repair of tibia. Operation delayed 16 days due to other complications.

remaining fragment rocks as it slides over the end of the femur, this fragment, also, should be removed, thus completing the patellectomy. Only if there is smooth, gliding, rhythmic action of the patella in the patellar groove, are we justified in leaving the remaining fragment. This decision should, if possible, be made at the operating table and the patella removed—then. (3) In fractures of the patella where there is a small chip off either lateral margin or a lateral fragmentation it is sufficient to remove the fragment.

Fig. 18

Fig. 18. (Case 10) D. H. This patient had marked restriction on motion of the knee following extensive giant cell tumor of the lower femur. Range of motion was improved following patellectomy for fractured patella.

(4) Patellectomy is done in all remaining fractures. Let me repeat that patellectomy is the treatment of choice and not the method of exception. If the fracture of the patella cannot definitely fulfill the above requirements it must fall in the group requiring excision. Patellectomy is specifically advised for (a) all comminuted fractures involving over one-third of the bone; (b) transverse fractures through the middle third of the patella; (c) fractures with gross damage of the articular cartilage, even though the fracture, itself, may be incomplete; (d) all cases of malunion of the patella; (e) all cases of nonunion of the patella.

It is the opinion of the author that if surgeons will carefully scrutinize the results of treatment of their fractures of the patella, they will, of necessity, come to the conclusions narrated above; namely, patellectomy must be considered the treatment of choice in treatment of fractures of the patella with other methods reserved for certain specific types of fractures.

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## EDITORIAL

We of the Surgery Department of the University of Oklahoma School of Medicine are happy to prepare the material for this issue of THE SOUTHERN SURGEON. In a sense, it is asking you to come into our laboratories, our library, our wards, and our surgery, to discover the type of work and study done therein and of course, being human, we hope you find it good.

At the same time, we are fully conscious of the fact that the complaint quite frequently made in regard to surgical literature is that much of it is ostentatious and repetitious. On the other hand, may we point out that much experience, particularly medical and surgical, is actually re-statement, however variable and diverse it may be.

Certainly, it is not obligatory that all surgical literature announce startling discoveries. Progress is and has been painfully slow in this vast and complex field. One needs only to point out that the early Hindus used forehead pedicle flaps for the plastic reconstruction of noses removed for perfidy. Further, the ancient Egyptians exterior-

From the Department of Surgery, the University of Oklahoma School of Medicine and the University Hospitals.

ized anal fistulae by manipulating loops of wire. These procedures have been adopted and adapted to modern practice and their improvement must be the result of repeated effort and observation. But, despite all this, the central idea is older than the calendar.

In addition to the charting of progress, the current and often repetitious flow of literature may serve other useful functions. If, as has been repeatedly said, many points of theory and practice fit like pegs in the doctors' memory, then their reiteration in current literature furnishes a source for the replacement of those that have fallen out. Therefore, a concise review is frequently not only timely but illuminating and refreshing.

The reader may be entirely familiar with results here reported and the conclusions drawn therefrom, yet the presentation affords an opportunity for comparison of work. By examining his own experience, the reader may be compelled to adjust his ideas and, in so doing, discover a new and better approach to an old problem. In such a course, progress lies.

In a few instances the criticism of ostentation is wholly or partially justified. Although the material submitted for publication may excite a varying degree of critical analysis, the surgeon, like the pie vendor, is only showing his wares and desires not only to be judged by those capable of so doing but to be identified with them.

We therefore submit our contributions in this spirit. We promise no world-shaking revelations but only a review of the type of surgery which is being performed at the University of Oklahoma Hospitals and of which we are proud.

L. J. STARRY, M.D., *Chairman.*

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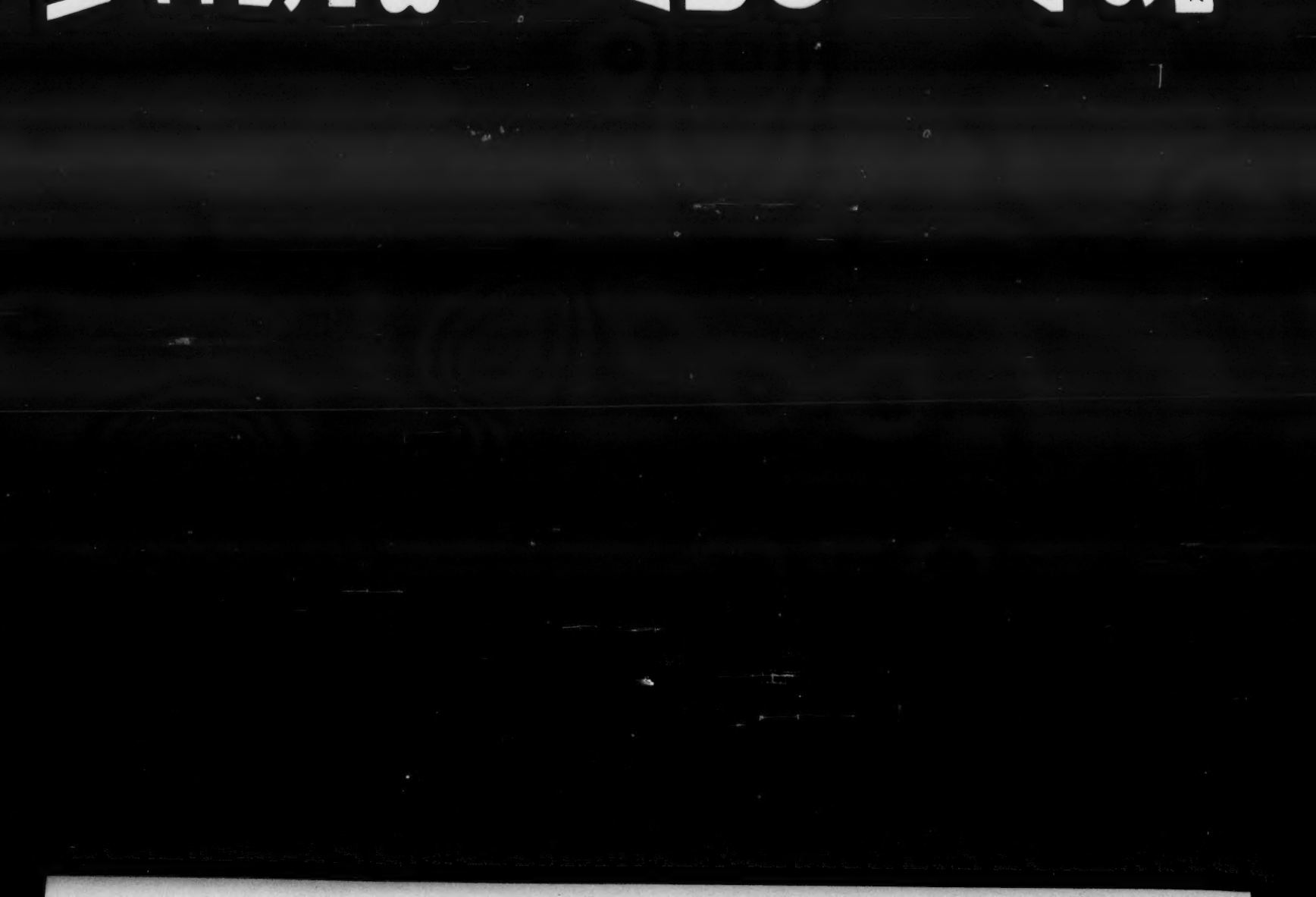
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